PSYCHOLOGY

A STUDY OF MENTAL ACTIVITY

HARVEY A. CARR

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PSYCHOLOGY

A STUDY OF MENTAL ACTIVITY

BY

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PREFACE

This text has been written rather compactly. It aims to present a clear, matter-of-fact and concise statement of general principles with just enough illustrative material to enable the student to comprehend those principles. This mode of presentation presumes that the text will be used as a basis for class discussion, and that it will need to be supplemented with a considerable amount of exposition and illustration by the instructor. In other words, the use of the text presupposes a teacher rather than a mere quiz-master.

One omission may be noted, — a chapter devoted to the unusual and abnormal aspects of mental development. Such material is not only interesting in itself, but it also illuminates by way of contrast our concepts of normal development. The omission is due in part to the limitations of space, and in part to some degree of scepticism on the part of the author of his ability to treat this complex topic in a brief yet comprehensive manner. The instructor who so desires can readily supply this material by means of lectures or supplementary reading.

Acknowledgments are made to the D. Van Nostrand Co. for permission to reproduce certain figures. I wish to express my indebtedness to Professor E. S. Robinson who has painstakingly read the first draft of the entire manuscript. Acknowledgments are also made to Professors J. H. Tufts, C. J. Herrick, F. A. Kingsbury, L. L. Thurstone, and Mr. A. W. Kornhauser for their critical and suggestive com-

ments on certain chapters. Dr. Margaret Miller has kindly aided in compiling the index and in preparing the lists of chapter exercises. Finally, I wish to express my obligations to a considerable body of students whose critical comments, sympathetic attitude, and stimulating interest have been largely responsible for whatever merits the text may possess.

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PSYCHOLOGY

CHAPTER I

INTRODUCTION

The Subject Matter of Psychology. — Psychology is primarily concerned with the study of mental activity. This term is the generic name for such activities as perception, memory, imagination, reasoning, feeling, judgment, and will. The essential features of these various activities can hardly be characterized by a single term, for the mind does various things from time to time. Stated in comprehensive terms, we may say that mental activity is concerned with the acquisition, fixation, retention, organization, and evaluation of experiences, and their subsequent utilization in the guidance of conduct. The type of conduct that reflects mental activity may be termed adaptive or adjustive behavior. The concept of adaptive behavior is discussed in some detail in Chapter IV, and for the present we shall merely state that an adaptive act is a response on the part of an organism in reference to its physical or social environment of such a character as to satisfy its motivating conditions. Illustrations of these mental operations may be drawn from the professional education of a physician. At times his mind is mainly engaged in the task of acquisition from lectures, books, and clinics, or from his experiences as a practitioner. At other moments his mind is primarily engaged in the attempt to memorize certain important data. Again, the reflective activities may pre-

dominate, and his mind is concerned with the task of analyzing, comparing, classifying, and relating the data in hand to other aspects of his medical knowledge. Finally comes the aspect of adaptive conduct, — the use of this knowledge and skill in diagnosis, treatment, or surgical operation.

Every mental act is thus more or less directly concerned with the manipulation of experience as a means of attaining a more effective adjustment to the world. Every mental act can thus be studied from three aspects, — its adaptive significance, its dependence upon previous experience, and its potential influence upon the future activity of the organism. For example, perception is a constituent part of a larger act; it is a process of cognizing objects on the basis of what we are doing, or in terms of their relation to some contemplated mode of behavior. Perception also involves the use of past experience, for the significance of any object can be appreciated only in terms of our previous experiences connected with that object. Likewise every experience with an object is likely to exert some effect upon the way in which that object is apprehended on subsequent occasions.

The importance of these various aspects of mental activity is apparent on a moment's reflection. Retention is essential to all learning, mental development, and social progress. The acquisition of an act of skill involves a series of successive trials or practice periods during which the act is gradually perfected and established. Each step of progress is a result of the preceding trials. The effects of each practice period are retained and it is these accumulated effects that render the succeeding attempts more facile. Without retention there could be no mind. If any individual should suddenly lose all his past experi-

ences, he would become almost as helpless as an infant (Chap. XI).

Our experiences must be properly organized and systematized in order to be utilized effectively. In popular speech, we often say that an insane person has lost his mind. As a matter of fact these people do have minds. They accumulate, organize, and evaluate their experiences in some sort of fashion, and they react to the world on the basis of these experiences. These people have disordered minds. Their experiences are improperly organized and evaluated. Theoretically, any group of experiences can be organized in various ways. An individual's manner of thinking and the character of his conduct are functions to a large extent of his previous organization. Certain types of organization are conducive to irrational modes of thought and to anti-social forms of behavior. Experiences must not only be organized, but they must be properly organized in order to be utilized effectively in reacting to the world in an intelligent and rational fashion (Chap. XV).

The mind is also continuously evaluating the various aspects of experience. The mind not only labels things as good, bad, and indifferent, but it also arranges the good things of life in a crude scale of relative worth. Æsthetic appreciation in the realms of literature, music, and the graphic arts illustrates this function. Ethical values may also be cited. We label social conduct as right and wrong and develop concepts of such virtues as charity, chastity, honesty, sobriety, and punctuality. An individual's system of values constitutes perhaps the most important aspect of his personality. Some students over-emphasize the relative value of study and become bookworms and grinds. Some boys attach too great an importance to the value of financial independence, and leave school to seek a job. Some

people under-estimate the importance of neatness of dress, correct habits of speech, courtesy, kindliness, and many other traits that make for an effective personality in social relations. Some individuals take their politics, their religion, or their science too seriously, and over-estimate the relative importance of those aspects of life. The nature and significance of this process of evaluation will be discussed at length in Chapter XIII, and for the present we merely wish to emphasize the fact that the mind does evaluate its experiences, and that an individual's conduct is to a large extent a function of his ideals and system of values.

All experiences of an individual during life are thus organized into a complex but unitary system of reaction tendencies that determine to a large extent the nature of his subsequent activity. The reactive disposition of an individual, *i.e.*, what he does and what he can and can not do, is a function of his native equipment, of the nature of his previous experiences, and of the way in which these have been organized and evaluated. The term 'self' is generally employed to characterize an individual from the standpoint of his reactive disposition. We also speak of an individual's personality when we wish to refer to all those traits and characteristics of his self that make or mar his efficiency in dealing with other individuals, while the term 'mind' is used when we wish to characterize an individual from the standpoint of his intellectual characteristics and potentialities. These topics will be discussed in detail in Chapter XV. Psychology is thus concerned with the study of personality, mind, and the self, but these are conceptual objects that can be studied only indirectly through their manifestations, — only in so far as they express themselves in the reactions of the individual.

The various concrete activities involved in an act of adjustment are the observable data and the subject matter of psychology.

The Psycho-physical Nature of Mental Activity. — These various mental operations that are involved in the performance of an adjustive response are usually termed psycho-physical processes. By their psychical character, we mean that they are acts of which the individual has some knowledge. For example, an individual not only perceives and reacts to an object, but he is at least aware of the fact and he may have some knowledge of the nature and significance of those acts. Individuals are not accustomed to reason, make decisions and react on the basis of those decisions and be wholly oblivious of the fact. The performance of any mental act on the part of an individual implies some sort of experiential contact with that act. For this reason we shall refer to these mental acts from time to time as experiences or as experiential activities. These acts are not only experienced, but they are also the reactions of a physical organism. They are acts that directly involve such structures as the sense organs, muscles, and nerves. The participation of sense organs and muscles in such activities as perception and voluntary acts is obvious. The nervous system is also concerned in every mental act. While this fact is not one of the obvious sort, yet the truth of the doctrine has been thoroughly established. The integrity of these structures is essential to normal mental activity. An excision or lesion in any part of the brain is usually correlated with some sort of a mental disturbance. All conditions that affect the metabolism of these structures also influence the character of the mental operations. We shall make no attempt to explain the nature of this psycho-physical relationship. We merely note the fact that

these mental acts are psycho-physical events and insist that they must be studied as such.

In contrast with our conception, mental acts are often identified with the psychical aspects of these adjustive activities. This doctrine assumes that these psycho-physical activities are composed of two parallel series of processes that belong to different orders of reality. There are the 'conscious' or immaterial processes on the one hand, and the organic or material processes on the other. The conscious processes constitute the subject matter of psychology, while the latter belong to the domain of physiology. Mind is thus defined in purely psychical or immaterial terms. Mental acts are regarded as a series of immaterial or psychical events that can occur only in conjunction with a series of physiological processes.

Two objections may be urged against this doctrine. 1. When we speak of the psychical or conscious characteristic of an act, we are dealing with an abstract or conceptual object that has no independent existential reality. This doctrine thus involves the logical fallacy of assuming that these conceptual objects are independent entities. Consciousness is an abstraction that has no more independent existence than the grin of a Cheshire cat. 2. By identifying mental acts with the psychical aspects of these adaptive activities, the exponents of this doctrine are logically confronted with the problem of explaining how these mental processes can exert any effect upon conduct. In other words, this conception necessarily raises the problem of the nature of the psycho-physical relation. We do not deny the validity of this problem, but we do assert that it is a metaphysical or philosophical problem that does not belong to the domain of an empirical or natural science.

According to our conception, psychology can not be dif-

ferentiated from physiology in terms of the metaphysical character of its subject matter. Both psychology and physiology are concerned with the study of the functional activities of organisms. Psychology is concerned with all those processes that are directly involved in the adjustment of the organism to its environment, while physiology is engaged in the study of the vital activities such as circulation, digestion, and metabolism that are primarily concerned with the maintenance of the structural integrity of the organism. Psychology and physiology are thus concerned with two mutually related and interactive groups of organic processes, and the details of this relation will be discussed at some length in Chapter XII.

Methods of Approach. — Mental acts can be studied from several avenues of approach. Mental acts can be directly observed, they can be studied indirectly through their creations and products, and finally they can be studied in terms of their relation to the structure of the organism.

Mental acts may be subjectively or objectively observed. Objective observation refers to the apprehension of the mental operations of another individual in so far as these are reflected in his behavior. Subjective observation refers to the apprehension of one's own mental operations. Subjective observation is often termed introspection, and in times past it was regarded as an unique mode of apprehension different in kind from that involved in perceiving an external event. As a matter of fact, the two processes are essentially alike in nature and they can be differentiated only in terms of the objects cognized (p. 111). Each mode of observation possesses certain advantages and limitations.

1. Introspection gives us a more intimate and comprehensive knowledge of mental events. Some mental events

can not be objectively apprehended. For example, we might know from an individual's behavior that he is engaged in thought without being able to tell what he is thinking about. The individual himself not only knows that he is thinking but is keenly aware of the topic under consideration. Neither will objective observation give us any clue as to whether these thoughts are mediated in terms of words or visual imagery (p. 173). Introspection often reveals the motives and considerations derived from past experience that influence us in any particular act. It would be very difficult to obtain knowledge of this character by the exclusive use of the objective method.

2. Subjective observations are rather difficult. Many mental operations consist of a series of complex and rapidly shifting events that are difficult to analyze and apprehend in a comprehensive manner. Inasmuch as our minds are usually engaged in dealing with objective situations, many people encounter a considerable amount of difficulty in the attempt to break this habit and become introspective.

3. The validity of a subjective observation can not always be tested. Given a report by a subject that he thinks by means of visual imagery, any verification or disproof of this statement is practically impossible inasmuch as this particular mental event can be observed only by that individual. Neither can we decide that the statement is untrue because other people assert that they think in verbal terms, for it is possible that individuals may differ in their manner of thinking. On the other hand, any objective act can be observed by several people and their reports compared.

4. Naturally the use of the subjective method must be confined to subjects of training and ability. Psychology must thus rely upon the objective method in the study of

animals, children, primitive peoples, and many cases of insanity.

5. Instruments may be used to record and measure any of the objective manifestations of mind. These records can then be analyzed at leisure. Acts can be detected in this manner that would otherwise escape our notice. For example, photography has been utilized as a means of studying the finer eye movements that are involved in an act of perception. This method has been extensively employed in the study of the perceptual activities involved in reading and in certain visual illusions.

Subsidiary to observation is the method of experimentation. In an experiment, the mental operations are observed under certain prescribed and defined conditions. An experiment is often called a controlled observation. An experiment may be relatively simple or quite complex according to the degree of control that is exercised. As an illustration of a simple type of experiment, we may cite the case of memorizing a list of words for the purpose of analyzing this process and discovering some of the conditions that influence our ability to recall this material on some subsequent occasion. In general, the performance of any mental act for the purpose of studying that act may be termed an experiment. A psychological experiment does not necessarily involve the employment of an elaborate technique and complicated forms of apparatus. The character of the apparatus is a function of the problem. Instruments are employed as a means of controlling the experimental conditions, or as a means of measuring and recording any feature of the experimental situation. The primary value of an experiment depends upon the fact that the observations are made under certain prescribed and specified conditions. An experiment is thus a means of discovering facts

and relations that would escape detection during the ordinary course of experience. Furthermore the results of any experiment can be tested by other investigators. The experimental method has its limitations in the field of psychology. Not all aspects of the human mind are subject to control. An individual's mental reactions are to a very large extent a function of his previous experiences. A complete experimental control of a human mind implies a freedom in manipulating its development throughout life in ways that are both impossible and socially undesirable.

The nature of mind may also be studied indirectly through its creations and products, — industrial inventions, literature, art, religious customs and beliefs, ethical systems, political institutions, etc. This method might well be termed the social avenue of approach. Naturally this method will not be used when the mental operations themselves can be studied. Consequently the method is mainly utilized in the study of primitive races or of past civilizations. The method in practice is essentially historical or anthropological. Obviously our knowledge of the human mind would be exceedingly limited if we were forced to rely exclusively upon such data. Facts of this character, however, are significant for an understanding of the developmental aspects of mind.

Mental acts can also be studied from the standpoint of anatomy and physiology. The structure of any organ and its functional possibilities are intimately related. The neurologist attempts to conceive of the structural arrangements of the nervous system in terms of their relation to the various activities in which they are involved. A study of the mutual relations between mental acts and the architectural features of the nervous system will obviously clarify the conceptions of both psychology and neurology.

We know that the character of mental acts is influenced by the metabolic conditions of the nervous system. Neural defects are frequently correlated with disturbances of perception, memory, recall, and voluntary activity. A considerable portion of our accurate and detailed knowledge of the relation of mental operations to the nervous structures has been gained in this way. Certain parts of the nervous structures are excised in animals and the effect of this loss of nerve tissue upon the subsequent ability of the organism is noted. Many features of mind must be explained in terms of the physiological peculiarities of the nervous system. The fact of retention, certain temperamental peculiarities of mind, and some aspects of the process of forgetting must be explained in this manner.

It is thus apparent that any fact is a psychological datum whenever it can be utilized in comprehending the nature and significance of the mental operations. The same fact may be significant to several sciences such as neurology, psychology, and physiology, and such a fact will constitute a part of the data of each of these branches of knowledge. Psychology like the other sciences utilizes any fact that is significant for its purposes irrespective of how or where or by whom it was obtained. No single avenue of approach can give a complete knowledge of a mental act. The various sources of knowledge supplement each other and psychology is concerned with the task of systematizing and harmonizing the various data in order to form an adequate conception of all that is involved in the operations of mind.

Facts of common observation constitute perhaps the major portion of the factual data upon which the present conceptions of psychology are based. Psychology differs from most of the natural sciences in that it deals to a con-

siderable extent with the obvious facts of everyday life. Mental acts are experienced events, and naturally everyone must acquire a certain amount of knowledge concerning his own mental operations during the course of life. A considerable portion of our time and energy is also devoted to the task of dealing with other minds. Everyone thus acquires a certain amount of psychological knowledge of a practical sort. Psychology as a science differs from the common sense variety in several respects. It observes and analyzes mental operations more carefully and systematically, it employs the experimental method whenever possible, it gathers its factual data from a greater variety of sources, and it attempts to construct a more adequate system of conceptions for comprehending these data. Any such system of conceptions is valuable only in so far as the student utilizes them in comprehending his own mental operations or in understanding the actions of others. To a large extent a student must regard a textbook of psychology merely as a guide to the study of his own mind.

Branches of Psychology. — The field of psychology is generally divided into a number of special branches, such as comparative, genetic, abnormal, general, individual, social, religious, educational, and applied. Psychology is interested in mental operations wherever found and irrespective of their peculiar character or complexity. Comparative psychology is concerned with the relatively simple and primitive mental capacities of animals in comparison with those of man. Social psychology considers those aspects of mental life that are peculiar to social interaction such as language, imitation, and suggestion. Abnormal psychology is concerned with the mental operations peculiar to hysteria, dreams, hypnosis, spiritualistic and somnambulistic trances, and insanity. General psychology

is concerned with the formulation of concepts and principles that are applicable to all varieties of mental operation no matter where found. General principles, however, must be illustrated in terms of and be applied to concrete conditions in order to be understood, and for this reason we may term this text a general psychology with a particular reference to the normal adult human mind.

Relation to Other Sciences. — So far as its systematic relations are concerned, psychology must be classed with the biological group of sciences which deal with the phenomena of living organisms. Psychology finds its closest kinship with physiology in that both are engaged in studying the reactions of animal organisms. There are no fixed lines of demarcation between the two fields. Psychology is interested in the adaptive reactions of organisms in reference to their environmental conditions in so far as those reactions are dependent upon their previous experiences. Physiologists have evinced but little systematic interest in this topic. They have been concerned for the most part with the study of the vital activities. If physiology be arbitrarily defined as the study of organic functions, psychology must naturally be regarded as a special branch of physiology. However, it is wholly immaterial whether psychology be regarded as subordinate to or coördinate with physiology. As a matter of fact, the two sciences do study different aspects of organic activity.

Psychology gathers materials from a great many fields of human endeavor. Psychology appropriates any facts that are significant for an understanding of mind. A professional psychologist naturally encounters a very limited range of mental phenomena and hence must gather his materials from a great variety of sources. Psychology takes facts from sociology, education, neurology, physi-

ology, biology, and anthropology, and hopes in time to be able to borrow from biochemistry. Most of our factual knowledge concerning the great variety of mental disorders has been contributed by physicians and psychiatrists. Peculiar facts of mind and personality are frequently contributed by the legal profession. The various practices of business and industry contribute many suggestive data. In fact, psychological materials can be gathered from any line of human endeavor.

Psychology in turn is interested in making whatever contributions it can to all allied fields of thought and endeavor such as philosophy, sociology, education, medicine, law, business, and industry. Naturally any knowledge of human nature will be extremely serviceable to any field of endeavor that is in any way concerned with human thought and action. While psychology has exerted a considerable amount of influence upon certain of these fields, yet this practical program must be regarded as somewhat of an ideal, for psychology has not as yet attained any very adequate or complete knowledge of human nature.

EXERCISES

1. Mental acts are experienced events, while the physiological processes are unconscious. Do you agree with this statement? Do we experience our breathing? Can you distinguish between psychology and physiology on this basis?

2. The statement is frequently made that psychology is largely theory. In what respects is the statement correct and in what respects is it not?

3. Have you ever performed a psychological experiment without knowing it? Illustrate.

4. Which is the more indebted to the other, psychology or medicine? Discuss.

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CHAPTER II

NERVOUS EQUIPMENT

The adaptive activities of an organism directly involve such structures as the sense organs, nervous system, and muscles. The intelligent possibilities of organisms are thus limited by their sensory, neural, and motor equipment, and in this and the following chapter we shall briefly sketch those aspects of these structures that condition an intelligent type of conduct.

The participation of sense organs and muscles in these adaptive reactions is obvious. Likewise, the connection between mental acts and the nervous system is a matter of common knowledge at present. This fact, however, was not firmly established until rather late in the history of thought. In ancient and mediæval times, mental activity was regarded as being intimately connected with such organs as the heart, lungs, or spleen, and writers of this time advanced some rather cogent arguments in support of their beliefs. Conclusive proof of the connection between mental operations and the nervous system is furnished by the fact that nervous lesions of various sorts may produce characteristic mental defects. A nerve lesion, for example, may condition the inability to understand the meaning of either a spoken or printed word. Many of the details of our knowledge concerning the relations of mental operations to the nervous structures have been gained in this way. Knowledge of these relations has developed slowly due to the difficulties inherent in this type of investigation. Mental defects can not be made to order with human sub-

jects. Accurate diagnosis often involves considerable psychological knowledge. The nervous examination must await an autopsy. Patients do not die at the convenience of investigators and permission for an autopsy can not always be secured. An accurate knowledge of nerve lesions presupposes an advanced development of microscopic and histological technique, and a considerable number of cases of each sort of defect must be obtained before any confident generalization can be made. While our knowledge of these relations is far from complete, yet the present data do justify the statement that some part of the nervous system is involved in every mental act.

There are two main divisions of the nervous system, the sympathetic and the cerebro-spinal. It is the latter division that is primarily involved in mental reactions, and our treatment will ignore many of its anatomical features and confine itself to those aspects that are intimately related to mental phenomena. In other words, we shall describe the nervous system as a mechanism for mental acts. 1. The nervous system conducts impulses from sense organs to muscles and glands. It is a device that translates sensory stimuli into movements of an adaptive character. 2. It offers a potential avenue of connection between each sensitive point in the body and each functional group of muscles. 3. It permits of motor coördination, — the simultaneous arousal of a large group of muscles by a single stimulus. A large degree of motor coördination is obviously involved in every act of an organism in reference to its environment. 4. A group of stimuli, each affecting a different sense organ, may coöperate in initiating a single response. In other words, an organism can react as a unit to a complex sensory situation. 5. The nervous system permits of a high degree of variability of response, — the ability of an or-

ganism to vary its response from time to time to the same stimulus. Without this possibility, organisms would be unable to learn, for learning involves a modification or change of behavior on the basis of previous experience. In more general terms, the nervous system makes possible a highly variable and coördinated type of behavior in response to any stimulus or any group of sensory data.

Cells and Tissues. — Cells constitute the anatomical units of living matter. There are micro-organisms, *e.g.*, the amœba, which consist of a single cell. Such a unicellular organism possesses all the functions of life such as sensitivity, conductivity, movement, reproduction, and assimilation. Most animals are multicellular, — aggregates of these cellular elements which have undergone considerable specialization in structure and function. One group of cells specializes on the reproductive function, another group on sensitivity, and another on contractility. Any group of cells with a common special function is called a *tissue*. The human organism is composed of a great variety of tissues, *e.g.*, muscular, glandular, osseous, adipose, and connective tissues. Nervous tissue is an aggregate of these cellular units whose prime function is that of *conductivity* and its cellular elements are so arranged as to offer a possible avenue of connection between each and every sensitive area and each functional group of muscles.

Neurones. — The cellular unit of nerve tissue is called a neurone. Its shape represents a considerable departure from that of its amœboid prototype. Its peculiar form, however, is one adapted to its function of connecting sense organs and muscles. A neurone is a long and very fine protoplasmic filament or fibre, with collateral branches, and arborized ends. Each fibre exhibits a slight bulbular enlargement at some place along its length. This bulbular

mass is called the cell body and it is usually located near one end. The majority of these fibres are covered throughout their length, with the exception of the cell body and the arborized ends, by a medullary sheath, — a substance that belongs to the fatty group of tissues. Fibres vary in length from a fraction of an inch to five feet. Their diameter is exceedingly small, being visible only with the aid

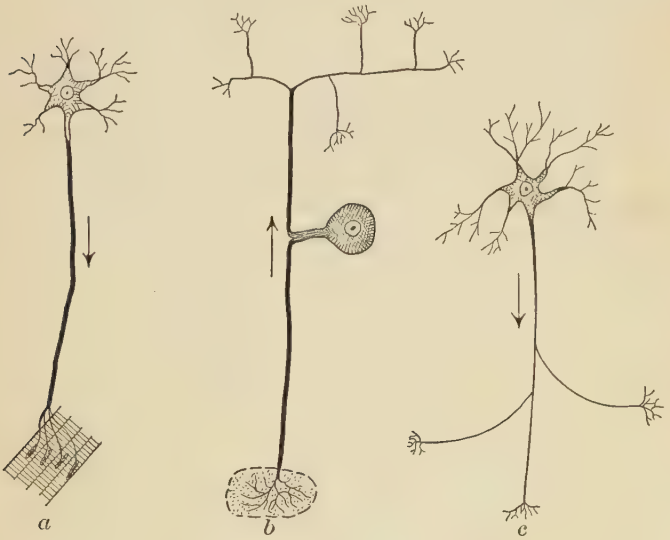

Fig. 1 — Types of neurones. *a*, motor; *b*, sensory; *c*, correlation.

of a highly magnifying microscope. The arborized terminals are also relatively short. Fibres vary as to their amount of branching and complexity of arborization. The volume of any fibre is very small in spite of its extension. The number of these elements in the human nervous system has been estimated as high as 3000 millions.

Typical neurones are represented in Figures 1 and 2. Such drawings, however, are likely to give the student a

very erroneous notion of the relative dimensions of these structures. The diameters of the fibre and cell body must be magnified approximately 1500 times in order to appear as represented. Since the majority of the fibres are at least six inches long, it would be necessary to represent them as 750 feet in length in order to draw them in proportion. The student is thus apt to obtain from these diagrams a very exaggerated notion of the relative size of the cell body. A neurone must be conceived as a very long, branched, and exceedingly tenuous fibre whose cell body is very inconspicuous in proportion to its length. From the standpoint of function, the essential features of a neurone are its length, its collateral branches and its arborized terminals. The value of length in connecting sense organs and muscles is obvious. The importance of the other two factors will be discussed later.

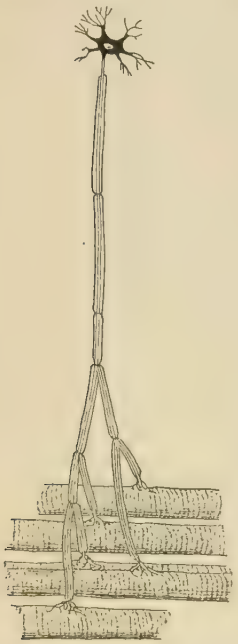

Fig. 2 — Motor neurone showing medullary sheath.

The nervous system is not composed entirely of neurones. As noted, the medullary sheath belongs to the fatty group of tissues and its volume is approximately equal to that of the enclosed fibre. The nervous system contains many blood vessels. It also contains a considerable amount of non-nervous tissue or neuroglia. These constituent elements of the nervous system will be ignored in our discussion. It is the neurones that are important for our purposes.

Serial Arrangement of Neurones. — The connection of a sense organ with a muscle is invariably mediated by a series of neurones. The impulse in passing from a sense organ to a muscle is thus transmitted from neurone to neurone, and the point of transference is termed a synapse. An impulse can pass across a synapse in but one direction. In other words, neurones exhibit polarity, *i.e.*, they conduct impulses in but one direction. The two ends of a fibre are thus differentiated in function. We may thus speak of the receptive end of a fibre as opposed to its transmitting terminals. Each fibre has but one receptive end, but it may possess in virtue of its collateral branches several transmitting terminals. The receptive end of a fibre may be identified in two ways: — It is usually the more highly arborized, and the cell body is more frequently located at or near this end. The receptive end is frequently referred to as the dendritic terminal as opposed to the end brushes or axonic terminals.

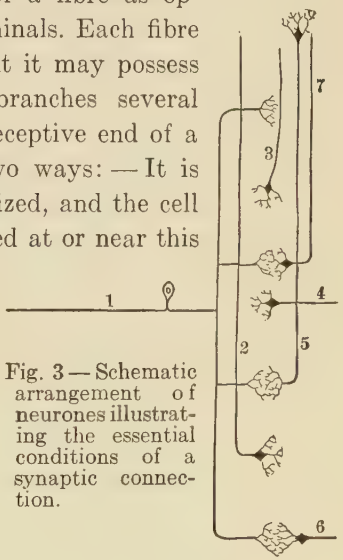

Fig. 3 — Schematic arrangement of neurones illustrating the essential conditions of a synaptic connection.

The essential condition of a synaptic connection is a close contact between two arborized terminals of opposite polarity. In Figure 3, an impulse conducted over fibre 1 can not be transmitted to fibres 2, 3, 4, and 5. There is contact with fibres 2 and 3, but not contact between two terminals. There is no contact with fibre 4, and the contact with fibre 5 is between terminals of similar polarity. The impulse can be transmitted only to fibres 6 and 7. There is no good explanation of the fact that transmission is

limited to the arborized terminals. It has been suggested that this is due to the absence of the medullary sheath from these portions of the fibre. This hypothesis assumes that the sheath prevents transmission to adjacent fibres in much the same fashion as does the insulating covering of an electrical conductor. However, the fibres of the optic nerve are in close contact and yet they are not medullated throughout their entire length.

Centres and Tracts. — Neurones are also arranged to form a series of centres and tracts. A centre is a common terminal for a multitude of fibres. A tract is a large

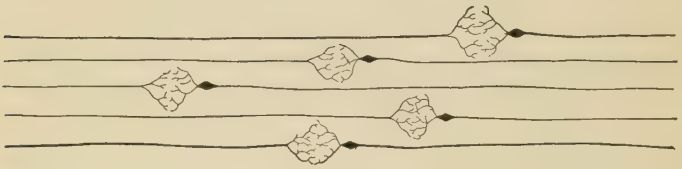

Fig. 4 — A hypothetical arrangement of neurones that does not permit of centres.

bundle of fibres having a common terminus within a centre. Centres and tracts differ in color. Centres are gray masses while tracts are white. This color distinction is due to the absence of medullation within the centre and its presence in the tract. Centres are composed of the non-medullated portions of the neurone, *viz.*, the cell body and the arborized terminals. The tracts consist of the medullated portion of the fibre. In the centres the nervous tissue is directly visible, and it presents a grayish appearance. In the tracts the nervous tissue is invisible because it is completely enveloped by the medullary sheath which like all fatty tissues is white. Tracts are conducting pathways. They conduct impulses from sense organs to centres, from centres

to centres, and from centres to muscles.[1] Centres are transmitting, relay, or distributing stations. A centre is an anatomical device that furnishes a large number of synaptic connections for each of the various fibres for which it is a terminal station. In the arrangement represented in Figure 4, the fibres do not meet in a centre, and each fibre has but a single synaptic connection. In Figure 5, the ten fibres have a common terminus, *i.e.*, they are arranged so as to form a centre, and as a consequence each neurone enters into synaptic connection with all five neurones of opposite polarity. The number of effective contacts secured by a fibre obviously depends upon the degree of its arborization. It is also apparent that a single transmitting terminal in a large centre can by means of its arborized filaments enter into synaptic connection with a very limited number of efferent neurones.[2] There are two anatomical devices that further increase the possibilities of interconnection within a large centre. One is the

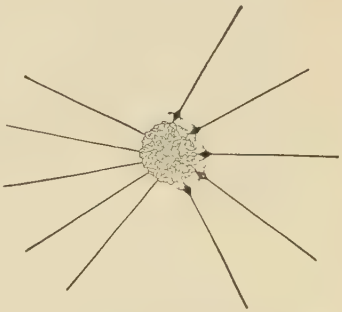

Fig. 5 — Arrangement of neurones to form a centre.

[1] The bundles of fibres that connect the sense organs and the muscles with the primary group of centres (p. 31) are usually called nerves, while the term tract is applied to those fibre bundles that are located within the central nervous system. The distinction is purely morphological, and when convenient we shall use the term tract in its wider connotation.

[2] Neurones that conduct impulses away from a given centre we shall call efferent, while the term afferent will be used to refer to a neurone that conducts impulses to that centre. It is thus obvious that the same neurone may be afferent in respect to one centre and efferent in respect to another.

phenomenon of collateral branching. Figure 6 represents a neurone with four collateral branches terminating in different localities within a long centre. By means of these branches, this fibre enters into synaptic relations with four distinct groups of efferent fibres. Correlation fibres constitute a second device. A correlation neurone is one that connects two different parts of the same centre. In Figure 6, the lower branch of the afferent fibre has synaptic connections with the efferent fibre 6 by means of a correlation neurone. Likewise the correlation neurone 9 mediates a connection between the upper branch of the afferent fibre and the efferent neurone 7.

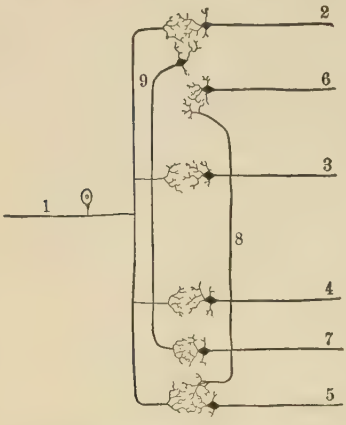

Fig. 6 — Diagram illustrating the indirect connection of afferent and efferent fibres by means of correlation neurones.

It is thus obvious that centres are anatomical devices that increase the number of synaptical connections. The synaptical possibilities furnished by a centre are a function of:

(1) the number of fibres terminating within it,
(2) the complexity of their arborization,
(3) the extent of their collateral branching, and
(4) the number of its correlation fibres.

It is thus possible in a large and complexly organized centre for each afferent neurone to have a synaptic connection with a multitude of efferent fibres.

Superposition of Centres. — Another anatomical device that increases the synaptic possibilities of the nervous system is the superimposed relation of centres. Centres are arranged in levels in reference to their relation to sense organs and muscles. All sensory fibres, those emanating from any sensitive area of the body, terminate in a primary centre. All motor fibres, *i.e.*, those ending in muscles, also find their origin within this centre. The higher centres are superimposed in reference to this primary centre in that no sensory impulse can reach them without first passing through this lower centre. Likewise the higher centres can never come into a functional relation with muscles except through the medium of the first centre. This conception of superimposed centres is schematized in Figure 7. Let S.T. and M.T. represent all the various sensory and motor tracts, *i.e.*, the various cranial and spinal nerves all of whose fibres terminate in the primary group of centres. Likewise C.T. represents the correlation tracts that serve to interconnect the sensory and motor fibres at this level. From this primary centre, there emerge sensory extension or projection tracts (S.E.T.) that may carry the sensory impulses to the second centre. Likewise the motor tracts are extended to the second level, and within this centre the extensions of the sensory and motor nerves are again interconnected by correlation fibres. This

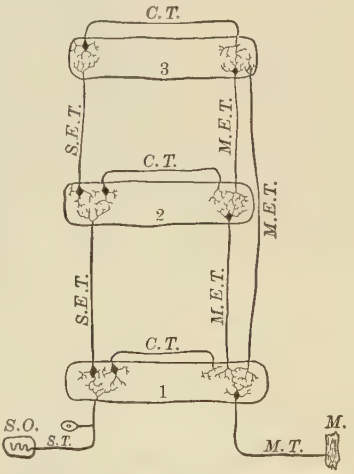

Fig. 7 — Diagram representing the superimposed relation of centres.

schematic arrangement is again duplicated at the third level with the exception that the first and third centres are also directly connected by a motor extension tract. In other words, the various sensory and motor fibres can become connected at any one of these three levels.

The cerebro-spinal system may thus be conveniently divided into three parts:

1. The sensory segments composed of the various sensory fibres and their extensions to the second and third levels.

2. The motor segments composed of the motor fibres and their extensions, and

3. The correlation tracts at each of the three levels. The reader must bear in mind at this point that the correlation tracts constitute but one of the means of interconnection. As noted in a previous paragraph, the sensory and motor fibres in each centre may enter into direct synaptic connection with each other by means of their collateral branches and arborized filaments.

Beginning students frequently develop the erroneous idea that these centres and tracts carry impulses to and from the brain, as though the brain were something in addition to what has been described. The brain is nothing but a mass of these neuronal fibres. In terms of our schematic diagram, the brain consists of the third centre with its correlation tracts and the various extension tracts connecting it with the second level of centres. Neither does the brain perform a function different in kind from that of the rest of the nervous system. The entire nervous tissue is a mass of fibres interpolated between sense organs and muscles and these fibres are arranged so as to permit of a highly variable and coördinated response to any sensory stimulus or to any group of sense data (p. 17). A

Fig. 8 — General distribution of the cerebro-spinal nervous system in the body.

variable and coördinated type of behavior would be impossible without centres.

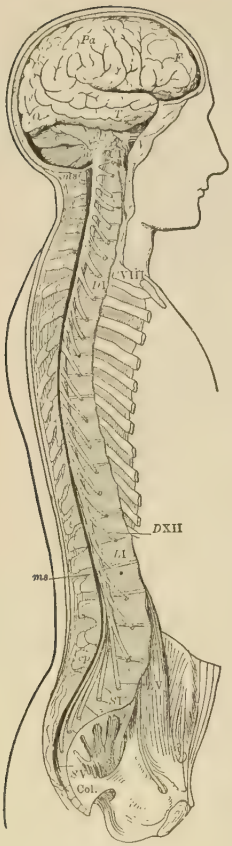

FIG. 9 — BRAIN, SPINAL CORD AND NERVE ROOTS.

A longitudinal section through the medial plane of the spinal column, and in part of the skull. Lobes of the cerebrum, *Pa*, parietal; *F*, frontal; *O*, occipital; *T*, temporal; *C*, cerebellum; *mo*, medulla oblongata; *CI* — *CVIII*, cervical nerves; *DI* — *DXII*, thoracic nerves; *LI* — *LV*, lumbar nerves; *SI*—*SV*, sacral nerves; *Col*, coccygeal nerve; *ms*, *ms*, upper and lower extremities of the spinal cord. (After Bougery.)

Gross Features of the Human Nervous System. — We shall next identify the various aspects of the above schema in terms of the neural structures. The student must not over-emphasize in his mind the importance of these morphological features. It is theoretically possible for two nervous systems to differ radically in their gross morphology and yet be on a par from the standpoint of their possibilities for mediating intelligent behavior.

The general distribution of the cerebro-spinal system in the body is represented by Figure 8. The brain is contained within the cranial cavity while the spinal cord is located within the spinal column (Fig. 9). There are eighty-eight nerves that emerge from these central structures and these subdivide into smaller and smaller branches as they approach the muscles and sensitive areas of the body. Sixty-two of these emerge from the spinal cord and are called

spinal nerves as distinct from the cranial nerves that find their origin within the cranial cavity. The continuation of the spinal cord inside of the cranial cavity is called the brain stem. From the posterior portion of this stem there has developed a large mass somewhat smaller than one's fist which is known as the cerebellum (Figs. 9 and 10). The top of the stem is somewhat enlarged and

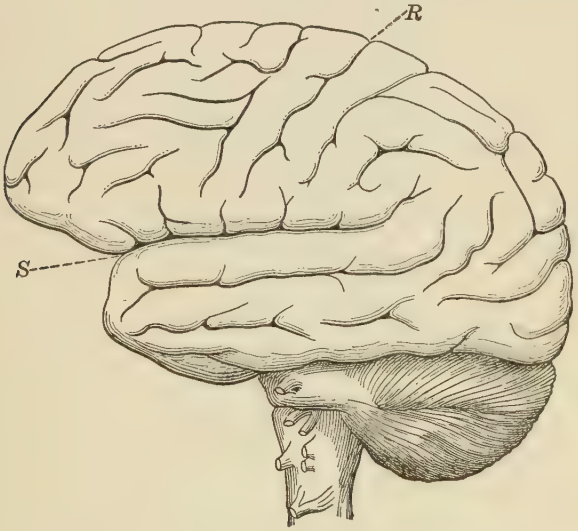

Fig. 10 — Cerebrum, cerebellum, and brain stem. *S*, fissure of Sylvius; *R*, fissure of Rolando.

here are located the optic thalami, one on either side (Fig. 11). From the front end of the stem have developed two very large structures known as the cerebral hemispheres. In their growth they have extended out in front of the stem, back over the cerebellum, and down over the sides of the stem so that the upper part of this structure is entirely hidden from view. The two hemispheres are separated from each other with the exception of a small area around the

upper part of the stem by a deep longitudinal fissure (Fig. 11). The surface of these hemispheres presents a convoluted appearance. Two of these crevices are quite deep and are called the fissures of Sylvius and Rolando (Fig.

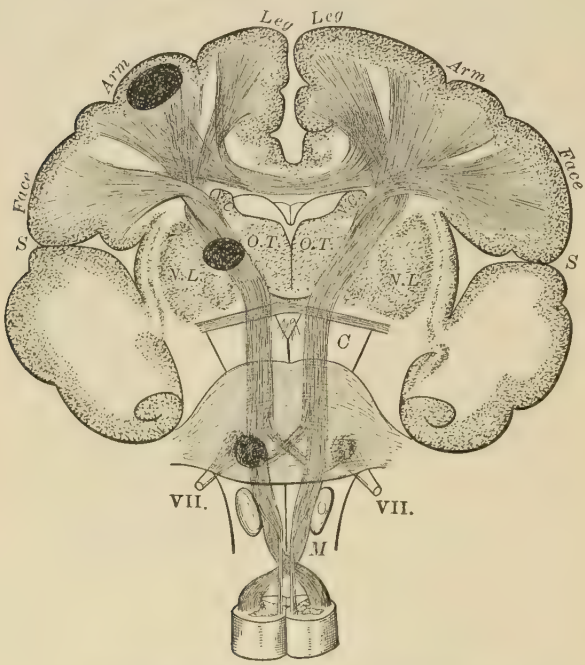

FIG. 11 — TRANSVERSE SECTION OF BRAIN REPRESENTING PROJECTION TRACTS, CORPUS CALLOSUM, AND BASAL GANGLIA.

Schematic transverse section of the human brain to show the crossing of motor fibres in the neighborhood of the medulla, through the Rolandic region. *S*, fissure of Sylvius; *N.C.*, nucleus caudatus, and *N.L.*, nucleus lenticularis of the corpus striatum; *O.T.*, thalamus; *C*, crus; *M*, medulla oblongata; *VII.*, the facial nerves passing out from their nucleus in the region of the pons. The fibres passing between *O.T.* and *N.L.* constitute the so-called internal capsule.

10). These serve as convenient landmarks in terms of which the locality of various areas can be described. The

part of the hemisphere located beneath the fissure of Sylvius is called the temporal lobe. The part located posterior to this fissure is the occipital lobe. The part located in front of the fissure of Rolando is called the frontal lobe, while the remaining portion of the hemisphere is known as the parietal lobe.

Distribution of Centres and Tracts. — The primary group of centres consists in the main of numerous small nuclei in the brain stem and the central core of gray matter that extends throughout the length of the spinal cord. The eighty-eight nerves are conducting tracts and are composed of sensory and motor fibres. It has been found that the spinal nerves contain approximately 1,700,000 medullated fibres. A recent study has indicated that the dorsal roots contain as many unmedullated as medullated fibres, — making a total of over 3,000,000 for the sixty-two spinal nerves. The total number of nerve fibres probably exceeds 4,000,000. The student must note that it is the neurone and not the nerve that is the unit of conduction. Each nerve is capable of carrying a large number of impulses simultaneously. Many nerves contain both sensory and motor fibres and hence conduct impulses in both directions at the same time. The receptive end of the sensory fibres is usually located in some specialized structure, or end organ, and its transmitting terminal is located in the primary centre. Upon entering the spinal cord, each sensory fibre divides into an ascending and a descending branch, and from these are given off a number of collaterals that terminate at the various levels of the cord in the manner represented in Figure 6. These sensory tracts are located in the posterior portion of the cord. The receptive end of the motor fibres is located in the centre, and the fibre emerges from the ventral side of the cord or brain stem and ex-

tends to a muscle. These sensory and motor fibres are relatively quite long. For example, the sensory fibres from the feet enter the spinal cord at its lower end and their ascending branches terminate at the upper levels of the cord. The spinal cord also contains small correlation tracts which run up and down the cord and serve to interconnect its various levels.

The second system of centres is composed of the cerebellar cortex and numerous nuclei in the upper part of the brain stem. The fibres of the sensory extension tracts originate at the various levels of the primary centre, run up the cord and brain stem, and terminate at various places in the secondary group of centres. The fibres of the motor extension tracts originate in the secondary centres, run down the stem and cord, and terminate at the various levels of the primary centre. The motor and sensory tracts are spatially differentiated in the cord. The motor tracts are located in the ventral and lateral portions of the cord, while the sensory tracts are situated in the lateral and dorsal columns. In the brain stem the various tracts present such a confused arrangement that any brief descriptive statement is impossible. The secondary system also contains a number of small correlation tracts.

The third centre is the cerebral cortex. It covers the entire surface of the cerebral hemispheres. The fibres composing the second extension of the sensory nerves originate in the upper part of the stem in the region of the optic thalami and enter the cerebrum by way of a large tract called the internal capsule. The fibres then radiate out in various directions and terminate at different positions in the cerebral cortex. The fibres composing the second extension of the motor nerves originate in the cortical area anterior to the

Rolandic fissure, pass into the stem by way of the internal capsule, and terminate either in some of the secondary centres or at various levels in the primary centre.

These projection tracts are diagrammatically represented in Figure 11. All those fibres constituting an extension of the optic nerve radiate backward and terminate in a small area of the cerebral surface located near the tip of the occipital lobe. This region is called the visual area of the cortex. The extension of the auditory nerve terminates in the temporal lobe immediately below the fissure of Sylvius. The termination of the olfactory tract is on the mesial surface of the temporal lobe, while the gustatory tract is supposed to end in the same lobe in an area situated between the auditory and olfactory areas. The somæsthetic tract, — that representing the sensitivity of the skin, muscles, and intraorganic regions, terminates in the area posterior to the Rolandic fissure, while the motor tracts find their cortical origin in the region in front of this fissure. The cortical terminations of the various nerves are represented in Figure 12. It is obvious from this figure that these motor and sensory tracts constitute but a small part of the cerebral hemispheres. At least three-fourths of the cerebrum is composed of correlation neurones that serve to interconnect the extensions of the various sensory and motor nerves. The cortical centre differs primarily from the two lower centres in respect to the size of its correlation tracts. The two lower centres contain relatively few correlation fibres, while in the cortical centre the correlation tracts constitute by far the greater portion of the mass of nerve tissue.

Just as an organism possesses two hands, two eyes, and two ears, so there are pairs of nervous structures. There are two auditory nerves, with their separate extension

tracts and distinctive cortical centres in the two temporal lobes. Likewise the muscles of the two arms are innervated

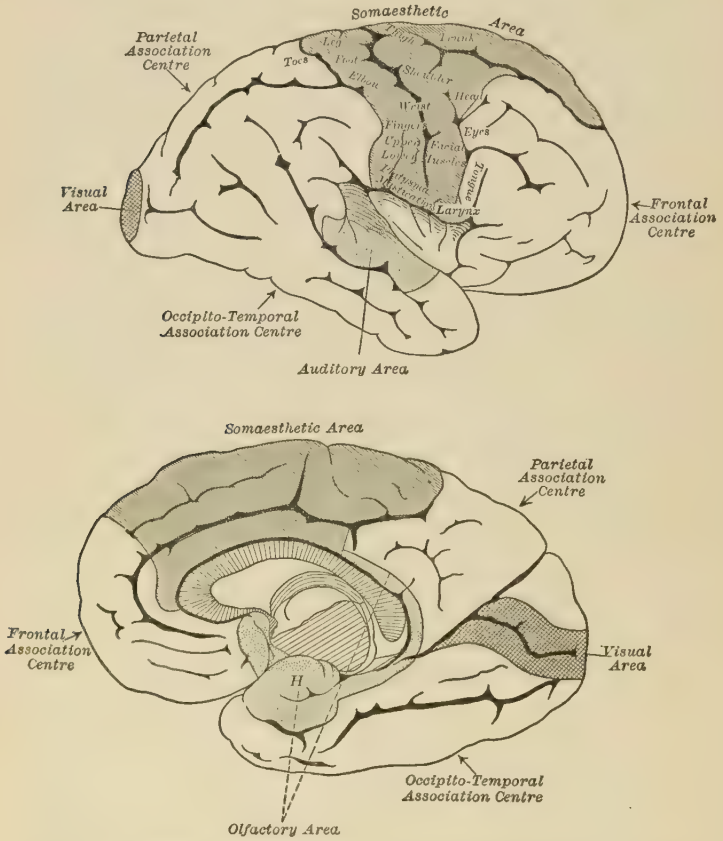

Fig. 12 — Diagrams representing the cortical terminations of the various sensory and motor projection tracts.

by separate motor nerves whose two extensions originate in different cortical centres. There are thus two kinds of correlation fibres, the commissural and the associational. The commissural fibres are those that connect the sym-

metrical parts of a centre. A fibre originates from practically every area of each cerebral surface and terminates in the symmetrical area of the opposite hemisphere. These fibres converge toward the centre of the hemispheres and form a very large tract as they cross the longitudinal fissure just above the top of the brain stem. This tract is known as the corpus callosum and it is represented in Figures 11 and 13. The associational fibres, on the other

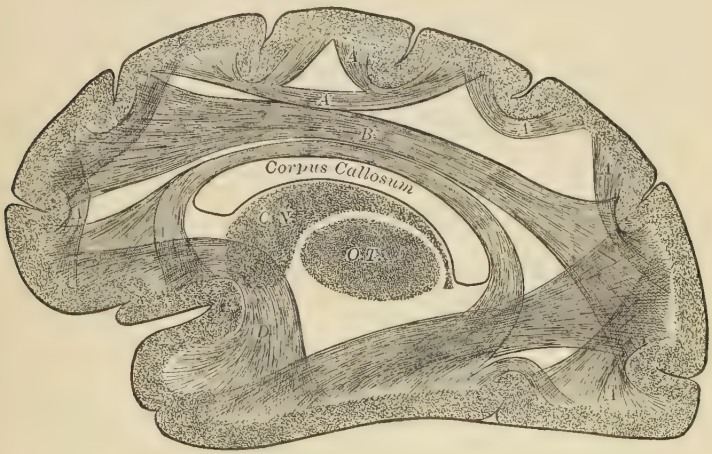

Fig. 13 — Cerebral associational tracts.

hand, have both their termini within a hemisphere and they serve to interconnect its sensory and motor areas in an intricate fashion. These associational tracts are represented in Figure 13.

Factors Influencing the Direction of Transmission. — A nerve centre is an anatomical device that offers to each afferent impulse many pathways of discharge. An impulse on coming to a centre may be transmitted to any one or any group of efferent fibres, and the direction in which the

impulse is transmitted may vary from time to time. In other words, a centre makes possible a highly variable and coördinated type of behavior. It is usually assumed that an impulse will be transmitted over that synaptic contact which for the moment offers the least resistance to its passage. There are several conditions that influence the resistance of the synapses and hence determine the route taken by any impulse through the nervous system. Innate conditions, intensity of the stimulus, habit, fatigue, and the variable metabolic conditions of the centres may be mentioned.

There are certain innate conditions which operate to transmit a given impulse in a certain direction. An impulse from a pain stimulus on reaching the spinal centre is invariably transmitted to a definite extension tract in the cord, while an impulse from a cold stimulus is transferred to another tract, and contact to a third. The various reflexes are illustrations. A sudden movement before the eye releases a retinal impulse which is invariably relayed back to the muscles involved in blinking.

Habit is another factor. The passage of an impulse across a synapse lowers its resistance and this effect persists and renders a repetition of the act more likely. This capacity of nerve tissue to modify its resistance as a result of its own activity is termed plasticity and the persistence of these modifications is termed retention.

The potential influence of fatigue and variable metabolic conditions needs no comment. Strong stimuli release impulses that overflow innate and habitual channels and are discharged over all possible avenues of conduction. An intense and unexpected noise, for example, will stimulate practically every muscle in the body.

The direction of transmission in any centre is also a

function of the relative resistance of other centres with which it is efferently connected. This conception is illustrated in Figure 14. An impulse carried along tract x will be transmitted at centre x to that motor centre y or z which offers the least resistance. Besides the factors already mentioned, the synaptical resistance in these motor centres is a function of their present state of activity. Let us suppose that centre z is the natural motor outlet for the tract x. At the same time that x is stimulated, let us assume

Fig. 14 — Diagram illustrating the neural mechanism involved in establishing new associations.

that the motor centre y is active by the stimulation of y. This activity in centre y so decreases its resistance that impulses from x are deflected toward it. A rat in traversing a maze has been taught the habit of turning around and retracing its path whenever it is stimulated by an electrical shock. An auditory stimulus will not produce this result. If the auditory stimulus be now presented a number of times in conjunction with the shock, the animal will thereafter retrace its path in response to the auditory stimulus alone. This act, originally initiated by the electrical stimulus, has become the motor outlet for the new stimulus. The nervous system thus acts to some extent as a unit in conduction. The reaction of an

organism to a given stimulus depends in part upon the character of the other sensory stimuli to which it is simultaneously subjected. An organism in its reactions is thus influenced by the total sensory situation in which it is placed.

The Neural Basis of Intelligence. — The capacity of a nervous system for mediating an intelligent type of behavior depends upon the existence of centres, their size and number, their superimposed relation, their plasticity, the degree to which the fibres are branched and arborized, and the relative number of correlation fibres. As we ascend the zoölogical scale, we find that these aspects of nervous development are roughly correlated with the increasing capacity of organisms for intelligent modes of response. For example, the lowest organisms have no differentiated nerve tissue. We next find a nerve net with no well defined centres, a nervous system with a primary centre, a nervous system with one superimposed centre, and finally a nervous system with two such centres. We find also a general increase in the size of the centres, the relative amount of correlational tissue, and in the extent to which the fibres are branched and arborized. Evidently the intelligent capacity of an organism is not closely related to any particular structural characteristic of the nervous system.

Several theories, however, have been advanced concerning the relation of intelligence to certain of the gross features of the nervous system. It has been proposed that the intelligent status of any organism is directly related to (1) the weight of the brain, (2) the weight of the brain relative to that of the body, (3) the area of the cerebral cortex which in turn is supposed to be largely dependent upon the number and depth of its

convolutions, (4) the size of the frontal lobe, (5) the size of the corpus callosum, and (6) the depth of the supragranular layer of the cortex. A considerable amount of data bearing upon the validity of these theories has been gathered by comparing the relative size of these structures in man and animals, in children and adults, in the two sexes, in primitive and civilized races, and in individuals of the same race who differ in their social and intellectual status. A certain amount of correlation obtains between the degree of intelligence and each of these morphological features but the exceptions are numerous and striking. For example, some of the animals have a larger brain than man, while in others the weight of the brain relative to that of the body is greater than is the case with man. Each of the theories contains a certain amount of truth, but all are defective in some respects.

All of these conceptions involve a common fallacy. The nervous system renders intelligent activity possible, and the more complex its structural organization the greater is its capacity for this type of activity. Nervous development is correlated with intelligent capacity and not with intelligent achievement. There is no necessary correlation between structural possibilities for mental development and actual achievements in this respect. A person may possess a highly developed nervous system without having attained any high degree of mental development just as an individual may possess a splendid vocal equipment and still be a very mediocre singer. The increase in mental development incident to advancing civilization is not based, at least within historical times, upon any corresponding nervous development. The intelligent status of an individual is dependent upon a great many other factors than that of his neural equipment.

Localization of Mental Functions. — In the early studies of the relation of nerve lesions to mental defects, it was noticed that a given mental defect was almost invariably associated with a lesion in a particular cortical area. After the discovery of several of these correlations, it was naturally surmised that possibly all mental traits and abilities are similarly localized. This conception assumes that each separate neural segment of the brain possesses a distinctive mental function, and that each aspect of the mind is dependent upon the functional integrity of some definite part of the brain.

This conception was soon disproved by further clinical progress. While there is yet much to be learned concerning the details of cerebral localization, yet on the basis of our present knowledge we may say that it is only the various sensory and motor functions that are localized. The location of these segments was described in a previous paragraph. Other abilities and mental operations are localized only in so far as they are dependent upon some sensory or motor function. Musical ability, for example, is localized only in so far as it is dependent upon audition. Most functions of the mind, however, are not thus exclusively related to some sensory process, and hence are not localized. For example, memory may involve any one or any combination of the sensory and motor mechanisms. The statement also holds for such mental acts as imagination, attention, reasoning, and will.

These statements directly contradict the doctrines of phrenology, although this conception was suggested by the early work on cerebral localization. Phrenology assumes that each distinguishable trait and capacity of mind is localized. It also assumes that any unusual development of a trait necessitates a corresponding development of the

cerebral structures involved, and that these morphological features of the brain are reflected in the conformation of the skull. No one of these assumptions is justified by the facts.

EXERCISES

1: Do the fibres that originate in a sense organ ever terminate in a muscle? Do the fibres that terminate in a muscle ever originate in a sense organ?

2. State the approximate length of the fibres of the auditory nerve, the fibres composing the corpus callosum, and the motor fibres that innervate the muscles of the foot.

3. State the various locations of the other end of all fibres that have a terminus in the spinal centre. Do likewise for the fibres that have a terminus in the cerebral cortex.

4. Does a high forehead indicate the possession of a superior mind? Is the intelligence of people proportional to the size of their heads?

5. The average weight of the brain of man is greater than that of woman. The weight of the brain does not increase after the fifteenth year of life. What is the relation of these two facts to the theory that the degree of intelligence is a function of brain weight?

6. Locate the synapses involved in the act of copying a sentence from a book, and in the withdrawal of the hand from a painful stimulus.

7. Suppose we cut the commissural fibres that join the two auditory centres in the cerebral hemispheres. What effect will be exerted upon the character of our auditory experiences?

8. What kind of activity would be exhibited by an organism if all fibres originated in a sense organ and terminated in a muscle? Would this arrangement permit of centres? What type of activity would be exhibited if the fibres were arranged as represented in Figure 4?

9. Apply the neural conception stated on page 37 to the process of learning to read. Is this neural process involved in the establishment of all new pathways? Is it involved in every act of learning? Can an organism be intelligent if it is unable to learn?

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CHAPTER III

SENSORY AND MOTOR EQUIPMENT

The intelligent capacity of an organism is also a function of its sensory and motor equipment. Obviously a highly developed nervous system would be of no value without a corresponding sensory and motor development.

The lower organisms react to as many kinds of material stimuli as does man, *viz.*, light, sound, temperature, contact, and chemical stimuli. Moreover, the entire surface of these organisms is sensitive. Man differs from these lower organisms, not in his range of sensitivity, but in his capacity to sense and react to these stimuli in a discriminative and differential manner. With the lower organisms, each sensitive point will respond equally well to all kinds of physical stimuli, and each of these stimuli will affect the organisms in pretty much the same fashion. Such organisms can not vary their conduct in accordance with the type of stimulus that affects them. From this primitive condition of relatively undifferentiated sensitivity, we find, as we ascend the zoölogical scale, a gradual development of discriminative sensitivity, — the ability to react differently to different kinds of stimuli. As a basis for this capacity, we find a corresponding development of special sensitive areas or structures, each adapted to respond to a particular kind of stimulus, and each mediating a particular kind of sensory experience. Sensitivity to light becomes restricted to one area, sound to another, while sensitivity to chemical stimuli becomes confined to other areas. In

their developed form these specialized sensitive structures are known as sense organs.

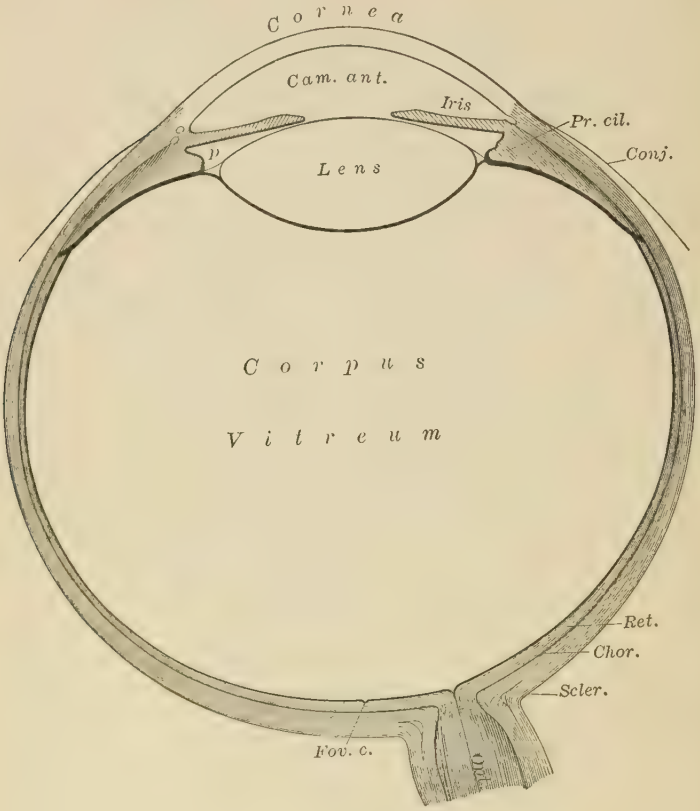

Fig. 15 — Cross-section of the human eye.

Scler., sclerotic coat; *Chor.*, choroid; *Ret.*, retina; *Opt.*, optic nerve; *Fov. c.*, fovea; *Pr. cil.*, the ciliary muscle or ciliary process; *Conj.*, conjunctiva; *Cam. ant.*, the anterior chamber; *Corpus vitreum*, the vitreous humor that fills the posterior chamber.

Modalities of Sense. — There are eight kinds of sensitivity, *viz.*, visual, olfactory, gustatory, auditory, static,

cutaneous, kinæsthetic, and organic. We shall briefly sketch the character of these sensitive structures, the kinds of stimuli to which they are adapted to respond, and the types of sensory experience which they mediate.

1. The retina of the eye is the sensitive area of vision and it is primarily adapted to respond to a certain restricted range of light waves (Fig. 15). It is the rods and cones of the retina (Fig. 16) that are directly affected by the light waves, and these sensitive structures in turn affect the fibres of the optic nerve with which they are connected. The retina does respond to other forms of stimulation, *e.g.*, to electrical stimuli and to pressure upon the eyeball, but its response is distinctive and specific, *i.e.*, it invariably mediates some kind of color experience irrespective of the kind of stimulus that affects it.

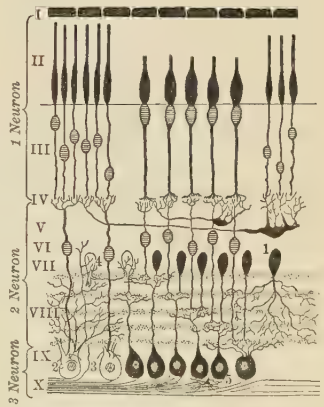

Fig. 16 — Diagrammatic analysis of the retina, showing the rods and cones and their nervous connections.

I, the pigment layer — the choroid coat; *II*, the rod and cone layer; *III*, the outer nuclear layer; *IV* to *VIII*, the layer of bipolar cells; *IX* and *X*, the ganglion cells and their nerve fibres which go to make up the optic nerve.

2. The olfactory area is located in the upper part of the nasal cavity (Fig. 17). It reacts to certain volatile substances and mediates the experience of odors.

3. Taste sensitivity is located in the marginal regions of the upper surface of the tongue and in certain regions in the back of the throat. These areas are responsive to certain soluble substances. The end organs involved are the

taste buds which are represented in Figure 18. Taste and smell are sometimes referred to as the chemical senses.

4. The sensitive structures of audition are certain hair cells that are located in the cochlea of the inner ear (Figs. 19 and 20). These hair cells respond to air waves of a certain restricted range of frequency and the resultant experiences are the sensations of tone and noise.

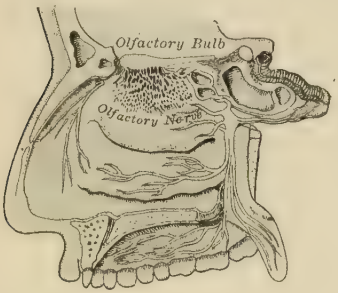

Fig. 17 — Distribution of the olfactory nerve in the nasal cavity.

5. The vestibule and semicircular canals of the inner ear (Fig. 19) constitute the mechanism of the static sense. Movements of the head and body are supposed to induce movements of the liquids contained in these cavities, and these latter movements affect the sensitive structures which are represented in Figure 22.

6. The skin and mucous membranes, *e.g.*, those lining the buccal and nasal cavities, are sensitive to mechanical impact, thermal stimuli, and various stimulating conditions that irritate or injure the tissues. Certain of the sensitive structures that are affected by these stimuli are represented in Figure 21. The skin mediates the experiences of contact, cold, warmth, and pain.

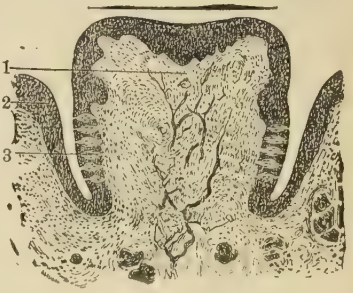

Fig. 18 — Cross-section of surface of tongue showing location of the taste buds. Taste buds are shown as *3*.

7. Kinæsthetic sensitivity is resident in the muscles.

Besides the motor nerves, the muscles are supplied with sensory fibres (Fig. 21) that are stimulated by external pressure and the contractile activity of these tissues. An individual can thus sense the movement of his arm when his eyes are closed.

8. The sensitivity of the various internal tissues is termed organic. It includes such sensory experiences as thirst,

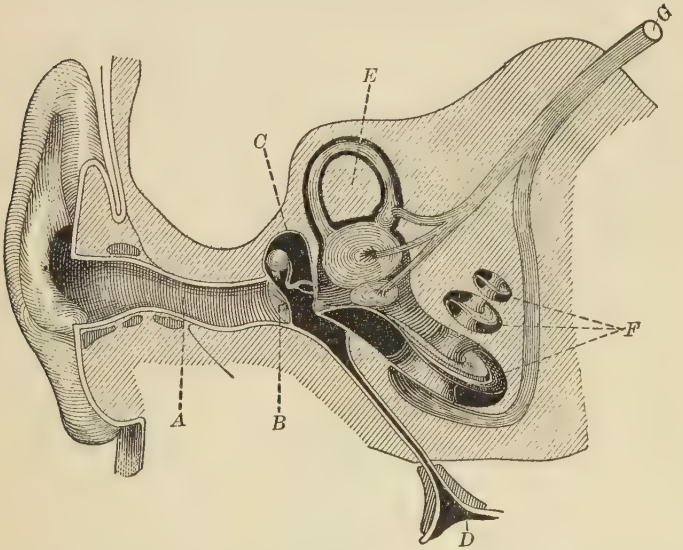

Fig. 19 — Diagram of ear. *A*, auditory meatus; *B*, tympanic membrane; *C*, cavity of middle ear; *D*, Eustachian tube; *E*, semicircular canals; *F*, cochlea; *G*, auditory nerve.

hunger, nausea, internal pains, etc. Cutaneous, kinæsthetic, and organic sensitivity are usually referred to as the somæsthetic group of senses. The importance of the somæsthetic senses is usually not appreciated by the casual observer. These senses exert a very profound influence upon the character of mental development (Chap. XII).

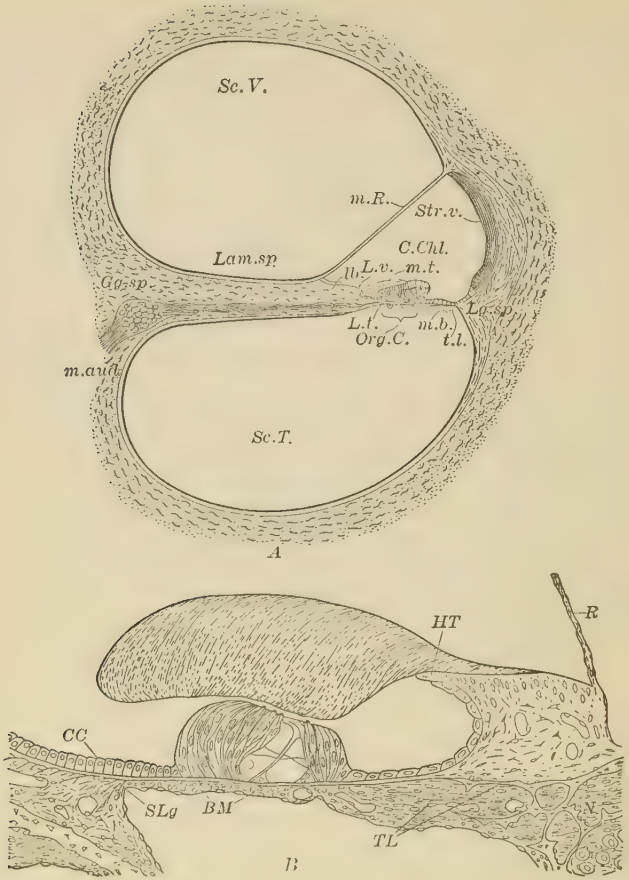

Fig. 20 — Cross-section of cochlea showing distribution of auditory nerve to the hair cells located on the basilar membrane.

A, typical cross-section of the cochlea. *Sc. V.* is the scala vestibuli; *m. R.*, Reissner's membrane; *C. Chl.*, cochlear duct; *m. b.*, basilar membrane; *m. t.*, tectorial membrane; *Org. C.*, organ of Corti; *Sc. T.*, scala tympani; *m. aud.*, auditory nerve; *Gg. sp.*, spiral ganglia with cell-bodies of the neurones making up the auditory nerve.

B, a cross-section of the cochlear duct of a pig showing: *HT*, tectorial membrane, hair cells and rods of Corti just below and resting upon *BM*, the basilar membrane. This membrane has a layer of cells on each side of it which would interfere with its free vibration. *R* is Reissner's membrane.

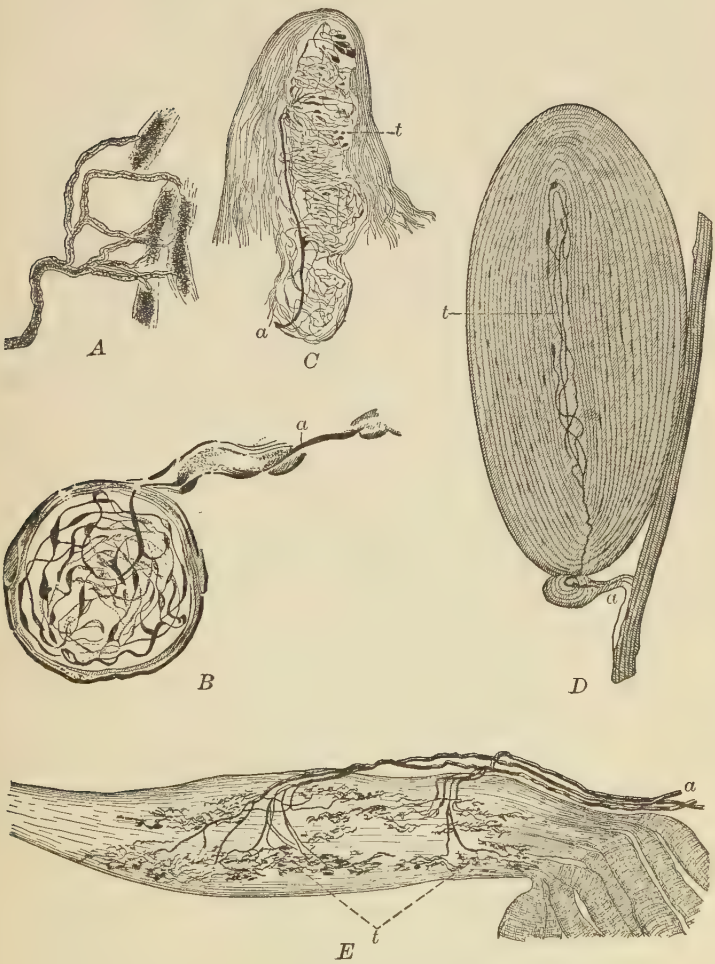

Fig. 21 — *A*, *B*, *C*, and *D*, sensitive structures in the skin; *E*, sensory fibres ending in muscular tissue.

There has been a further development of discriminative sensitivity within some of these sensory fields. For example, the skin is not uniformly sensitive, and any sensitive point may respond in several diverse ways. Evidently the skin must contain several specialized structures each of which is adapted to respond to a certain kind of stimulus and each of which mediates a definite sensory experience. The nature of these differentiations will be sketched at some length.

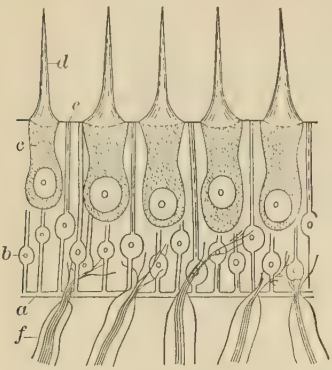

Fig. 22 — Sensory structures in the semicircular canals.

Cutaneous Sensitivity. — There are four special mechanisms in the skin which give the sensory experiences of cold, warmth, contact, and pain respectively. Contact responds to mechanical impact, cold and warmth to thermal stimuli, and pain to any kind of stimulus that irritates or injures the tissues. There are several lines of evidence that indicate the existence of these modes of cutaneous differentiation.

The first is the existence of several regions of peculiar sensitivity. There is a small region on the inner surface of the cheek opposite the lower molars which is called the Kiesow cheek area. This area is insensitive to pain, while cold, warmth, and contact are present. Warmth is absent in the cornea of the eye, while cold and pain are present. It is said that the tooth pulp is insensitive to cold and warmth but sensitive to pain. Pain is present in the viscera while the existence of cold and warmth in these regions is doubtful. These facts eliminate the possibility that these four

sensory experiences are functions of a single end organ.

There are certain drugs that affect these four senses differently. A weak dose of cocaine may eliminate sensitivity for pain without seriously affecting cold, warmth, or contact. The speed with which an individual can react to these four stimuli differs. These facts are readily explained on the assumption that there are four special structures involved.

The skin is not uniformly sensitive. If a blunt metal point be cooled and moved over the surface of the skin,

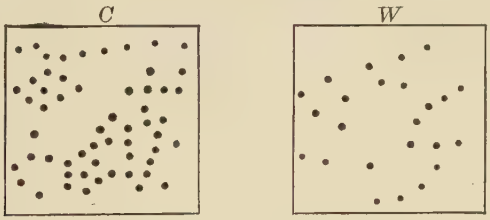

Fig. 23 — Distribution of cold and warm spots on dorsal surface of forearm. *C*, cold; *W*, warm.

its coldness will be appreciated only at certain spots, — the intervening areas being insensitive. These points of sensitivity are called cold spots. If the stimulation be intense, the metal point will be sensed as cold at all positions, but the sensory response will be more intense at the cold spots than in the intervening areas. Cold spots represent the points of maximum sensitivity, and it is assumed that the location of the cold spots corresponds to the distribution of the sensitive structures in the skin. Consequently, if a weak stimulus be placed between two spots, its strength will not be sufficient to affect these structures, while a very cold stimulus will irradiate and hence be sensed as cold irrespective of its position. The same con-

ception of spots is applicable to warmth and contact and possibly to pain.

A map of the cold and warm spots for a small area of the forearm is given in Figure 23. There is some evidence that these spots are fixed in position. The four kinds of spots differ in number for any given area of the skin. The pain spots are the most numerous, with contact, cold, and warmth following in order. Many points on the skin mediate more than one kind of sensory experience, *i.e.*, both cold and contact can be obtained from the same spot. In other words, several kinds of spots may have an identical location. The four kinds of spots, however, are independently distributed, and consequently each kind of spot often exists in isolation. For example, cold spots can be found that will not respond with warmth or contact, and other spots exist that are sensitive only to warmth, or contact, or pain. The existence of spots, their permanence in position, their difference in number, and their independent distribution indicate the existence of four sensitive mechanisms in the skin.

A study of the lesions resulting from certain spinal cord diseases proves that each of these sensory functions has a separate conduction path in the spinal cord. With a given lesion we may find that one leg is insensitive to cold but reacts to warmth, pain, and contact. Again we may find the loss of pain with the retention of cold, warmth, and contact. In general, any one or any combination of the four functions may be lost with the retention of the others.

There is some evidence that each of these special mechanisms is specific, *i.e.*, each mechanism invariably mediates a distinctive experience irrespective of the kind of stimulus that affects it. An isolated cold spot will sense

both cold and warm stimuli as cold. Warm stimuli applied to the cornea are usually sensed as cold. This phenomenon of paradoxical coldness is very readily obtained. Some observers report that an isolated cold spot will respond with cold when electrically stimulated. Some subjects obtain a paradoxical warmth from isolated warm spots while others are unable to do so. In other words, every stimulus is likely to excite more than one sensory mechanism. For example, hot water, in which the hand is immersed, will excite contact, warmth, cold, and pain.

Taste. — There are four taste mechanisms, — for sour, salt, sweet, and bitter respectively. These tastes are differently distributed over the surface of the tongue. The base of the tongue gives the maximum sensitivity for bitter. Bitter can be sensed on other areas but not at all readily. Sweet and salt are obtained most easily from the tip of the tongue. Sour can be sensed at several areas but the lateral edges of the tongue are the most susceptible to this taste as a rule. The distribution of tastes probably varies somewhat with individuals. As a consequence of the above facts, we find that the taste of a given substance may vary according to the area stimulated. A solution of saccharine tastes sweet when placed on the tip of the tongue but quite bitter at the base. Magnesium sulphate is slightly sweet and salty on the tip but very bitter at the base. These facts are readily explicable on the hypothesis of the existence of four special sensory mechanisms which are differently distributed on the surface of the tongue.

There are certain drugs which affect these tastes differently. A weak solution of cocaine may eliminate bitter without seriously interfering with the other three. A certain amount of gymnemic acid may destroy sweet and bitter without eliminating sour and salt. This selective ac-

tion of drugs also indicates the existence of several kinds of sensitive structure.

To casual observation, taste seems much more complex than the above analysis indicates. Food experiences, however, comprise olfactory, cutaneous, and kinæsthetic as well as taste elements. Edible substances are frequently identified in part by odor and their thermal and tactual character. In experiments in which odor is eliminated by stopping the nasal passages, and contact and thermal differences are largely eliminated by the use of food solutions, the ability to distinguish between edible substances is greatly impaired.

Visual Sensitivity. — No one doubts the fact of retinal differentiation. Practically all authorities assume that the retina contains three kinds of sensitive structure. The factual data are indecisive and ambiguous in some respects, and several theories have been proposed as to the range of stimuli to which each structure is sensitive and the types of sensory experience which they mediate. We shall briefly state the theory of Hering[1] and discuss its relation to the facts of visual sensitivity.

Hering assumes the existence of three specialized substances or structures. One mediates the experiences of red and green, another of blue and yellow, and the third of black and white. These substances have a zonal distribution in the retina. The black-white substance is found in all parts of the retina. The blue-yellow substance is absent in the marginal portions of the retina, while the red-green substance is present only in its central portion. The central zone of the retina is thus sensitive to all colors, the mar-

[1] The Hering theory has been chosen because most beginning students find it rather easy to comprehend. There are other theories that probably give a more satisfactory account of the facts of color vision.

ginal zone is sensitive to only black and white, while the middle zone is sensitive to all colors except red and green. The pair of colors belonging to each substance represent antagonistic processes. Hering assumed that the activity underlying these sensory experiences is either a rise or fall of the metabolic level of the substance. Blue, green, and black are associated with a rise in the metabolic level of the three substances, while yellow, red, and white are obtained whenever the metabolic level falls. Hering further assumed that all light stimuli that enter the eye stimulate the black-white substance, while each of the other two substances can be stimulated only by a restricted range of wave lengths. According to this assumption, every stimulus that arouses a chroma, *viz.*, red, yellow, blue, green, or any of their combinations, will also stimulate black and white. It is thus impossible to experience a pure chroma. All chromas, even those of the spectrum, contain an admixture of black and white. Certain wave lengths excite two chromas in addition to black and white, and this fact accounts for such spectral color blends as orange or red-yellow, yellow-green, blue-green, and violet.

There are several well attested types of *color blindness.* In the first, it is generally assumed that the experience of red and green is lacking and that all red and green objects are perceived as yellow, blue, or gray. The purples and blue-greens are sensed as blue, the oranges and yellow-greens are perceived as yellow, while certain reds and greens are seen as gray. Hering assumed that this defect is due to the absence of the red-green substance. Hence all purples and blue-greens, which are mixtures of blue with red and green respectively, will appear as blue to an individual afflicted with this type of color blindness. Orange and yellow-green objects will likewise be perceived

as yellow. Those reds and greens which contain no admixture of yellow or blue will be perceived as gray, since all chromas to the normal eye contain a gray component.

In a second type of defect, blue and yellow are assumed to be lacking, and hence oranges and purples will appear as red, yellow-greens and blue-greens as green, and pure yellow and blue as gray. In this case, Hering assumed the absence of the blue-yellow substance.

In a third type of color blindness, objects differ only in brightness and not in color. It is generally assumed that all objects are perceived as gray. Hering assumed that this defect is due to the absence of the red-green and blue-yellow substances. Consequently all chromas will be perceived as gray since all stimuli excite the black-white substance.

The theory encounters certain difficulties. According to the theory, one substance should be lost just as readily as another, while as a matter of fact the black-white type of blindness does not exist, the red-green defect occurs very frequently, and the yellow-blue type of blindness occurs but rarely. According to the theory, it is impossible to lose red and retain green, and there is some evidence that indicates the existence of this type of blindness.

Hering's theory gives a rather adequate account of the facts of *color mixture*. Obviously all perceptible colors must be regarded as a combination of some of these six elements, and undoubtedly they can be so produced. In mixture, all pairs of colors can be classed as antagonistic, or non-antagonistic. Non-antagonistic pairs when mixed give blends, — a product which is similar to the two components. A mixture of blue and green gives a blue-green; yellow and green, a yellow-green; red and yellow, an orange; and blue and red, a purple. Mixture of antagonists

never gives a blend. Spectral blue and yellow, and the Hering red and green are antagonists. Mixture of blue and yellow gives a blue, a yellow, or a gray according to the relative strength of the two components. There are no blue-yellow or red-green colors in nature and neither can they be produced by mixture.

Hering assumed that antagonistic pairs of colors are functions of the same substance. Blue and yellow are associated with a rise and a fall of the metabolic level of one substance. When the two stimuli affect this substance, its level can not rise and fall simultaneously; it will either rise, or fall, or remain stationary according to the relative strength of the two opposing stimuli. Consequently either blue or yellow will be experienced, or both chromas will disappear when the two stimuli are properly balanced. In the latter event, gray will be perceived because both stimuli also affect the black-white substance. In fact, the theory assumes that gray can be perceived only when antagonistic chromatic elements are balanced so as to cancel each other. White light contains all possible chromatic stimuli but in such proportions that neither the blue-yellow nor the red-green substances are excited, and consequently only the white-black process is active. The non-antagonistic pairs, as red and blue, and yellow and green, are functions of different substances which can act in entire independence of each other. A fall of the metabolic level of the red-green substance can occur simultaneously with either a rise or fall of the level of the blue-yellow structure. A mixture of red and blue is regarded as the simultaneous perception of the two components. Mixture of non-antagonists is thus a summation process.

The main defect of this theory of mixture is the assumption that black and white are antagonists. On this hypothe-

sis, it should be possible to mix black and white in such proportions that they will cancel each other and nothing will be visible. Black and white are in reality non-antagonistic colors and their mixture produces a blend of gray. Hering's theory was later modified to meet this difficulty.

The *negative after-image* phenomenon is readily explained in terms of the metabolic conception. If one fixates a blue object steadily for forty-five seconds with good daylight illumination and then removes the stimulus, the antagonistic color, yellow, will be perceived. The after-image of yellow is its antagonist blue. Red is the after-image of green, and green of red. The after-image occurs automatically; it can be perceived with either open or closed eyes. When a stimulus causes the metabolic level of the blue-yellow substance to fall, yellow is perceived. With the removal of this stimulus, the level automatically rises to its normal status, and by hypothesis blue will be experienced. Since the metabolic level when disturbed by a stimulus must return to its normal equilibrium, the perception of any color must induce an after-image of antagonistic hue. Hering again meets difficulty with the white-black relation. Intense white light, or strongly illuminated white surfaces give chromatic after-images whose color changes as the image fades away. This phenomenon is known as the flight of colors. Chromatic after-images from white light can not be readily explained in terms of the theory.

There are certain peculiarities of *peripheral color sensitivity*. When a small piece of colored paper is moved from the centre of the field of vision to the periphery, it undergoes certain color changes. All chromas become less saturated and finally change to a gray; all chromas except four change to either a blue or a yellow before passing into

gray; the four chromas that pass into a gray without undergoing a chromatic change are termed stable colors, and these were chosen by Hering as his chromatic elements, red, green, blue, and yellow. Hering explained these facts in terms of his assumption of the zonal distribution of the color substances. The middle zone is red-green blind, and hence all purples and blue-greens will appear as blue when this zone is stimulated. Oranges and yellow-greens will likewise appear as yellow. In the outer zone both the red-green and blue-yellow substances are absent and hence all chromas appear as gray.

Later experiments have shown that all chromas can be perceived in the periphery, provided the stimulus be sufficiently large and intense. Peripheral vision can not be explained in terms of color blindness. It is also known that the removal of a stimulus from the centre to the periphery of the field of vision decreases the amount of light from the object that enters the eye, because the amount of light reflected from the cornea is increased and the size of the pencil of rays that can enter the pupillary aperture is decreased. It is now generally assumed that the three substances on the periphery differ in limen. The black-white substance has the lowest limen, *i.e.*, it is most easily stimulated, while the red-green substance has the highest limen. This conception will readily explain the factual data. As an orange stimulus is moved toward the periphery, the red will first drop out because of its high limen, and then yellow will disappear, leaving only the gray component visible. If the stimulus be sufficiently intense, neither the red nor yellow will disappear, and the object will be perceived as orange in all parts of the field.

Audition. — It is generally agreed that each auditory mechanism is adapted to respond to a certain range of

wave lengths and mediates the experience of a definite pitch. The number of mechanisms is assumed to equal the number of pitch discriminations of which the ear is capable. The maximum number of tonal discriminations is generally estimated at 11,000.

This conception is supported by the phenomena of auditory analysis and tonal defects. Individuals are often unable to distinguish pitch in some part of the musical scale. It has been found that such tonal defects are correlated with lesions in definite portions of the cochlea. Lesions at the base of the cochlea produce defects in the upper part of the scale and lesions at the cochlear apex are associated with tonal defects in the lower part of the scale.

It is known that the sound waves emitted from several simultaneously vibrating bodies fuse or are combined into a single composite wave in their passage to the ear. The physical stimulus affecting the ear is a unit, but the organism can hear it as complex. This ability of the ear to perceive such a unitary stimulus as a combination of tonal elements is termed auditory analysis. The perceptual elements into which such stimuli are resolved are invariably *pitch* differences. In order to explain this phenomenon of pitch analysis, it is necessary to assume that the stimulus is capable of affecting a definite group of structures, each of which is associated with a tonal experience of a given pitch.

There is no general agreement at present as to the nature of the analytical mechanism of the ear. Very intricate problems of physics and anatomy are involved in a consideration of this question. Helmholtz regarded the fibres of the basilar membrane as the analytical structures (Fig. 20). He assumed that these fibres are stretched and hence can be set in vibration according to the physical principle of

sympathetic resonance. The fibres are known to differ in length, and Helmholtz supposed that they also vary in thickness and tautness and hence vary in their natural vibratory rate between quite wide limits. A fibre of a given rate can thus be set in motion only by a sound wave of a corresponding frequency. The vibratory activity of these fibres is supposed to excite the adjacent hair cells which are directly connected with the fibres of the auditory nerve. The conception explains fairly well the more obvious facts of audition, but it has been seriously criticized on the basis of its physical and anatomical assumptions.

Smell. — Differentiation undoubtedly obtains for smell, but we have at present no definite knowledge as to its extent and character. There are several serious difficulties involved in obtaining any decisive data in this field. A subject quickly becomes adapted to these stimuli. An odor will gradually fade and disappear while it is being observed. The olfactory area is inaccessible to direct experimentation. Olfactory stimuli are difficult to control as they diffuse through the air. For these reasons one can not experimentally compare the sensitivity of different portions of the olfactory area as one can with the skin, the tongue, and the retina.

Intraorganic Sensitivity. — There is some differentiation within the general field of intraorganic sensitivity. Pain can be secured from these regions as well as from the skin. Some maintain that temperature sensations can be secured from the alimentary canal while others deny the fact. Kinæsthetic sensitivity can also be obtained from the muscles, and it is generally agreed that this sense is not further differentiated. Probably other modes of sensitivity can be obtained from the internal organs, but there is little agreement concerning their nature.

Spatial Discrimination. — This topic will be more adequately discussed in a subsequent chapter on Space Perception. For the present we wish to note several facts concerning the phylogenetic development of spatial sensitivity.

1. There has been a development of localizing ability. Primitive organisms manifest but little ability to vary their responses as the position of the stimulus on the surface is shifted. The capacity to discriminate between stimuli on the basis of their location increases rapidly as we ascend the zoölogical scale. The human organism can react to the locality of a contact stimulus or to the position of an object in the visual field with a high degree of accuracy. Presumably this capacity is primarily dependent upon the number of neural fibres that are distributed to a given area. Localization on the finger tips is much finer than on other parts of the body and these areas possess the richest nerve supply. Visual localization is more accurate than cutaneous, and the retina contains more sensory fibres per unit of area than does the skin.

2. The capacity for form and size discrimination in sensitive surfaces obviously increases with their development in localizing ability.

3. Another characteristic feature is the development of distance sensitivity. The eye and the ear are commonly called distance receptors. The sensory-motor capacity of primitive organisms is largely confined to objects with which they are in close contact. With the highly developed senses of sight and hearing, the human organism can not only sense the presence of distant objects, but can respond to these objects on the basis of their position in space.

Value of Discriminative Sensitivity. — Intelligent or adaptive conduct is dependent in several ways upon this sensory capacity whose development we have so briefly

sketched. Distance sensitivity furnishes many advantages. The value of sensing dangerous objects at a distance especially in primitive conditions of life is obvious. Distance sensitivity brings the organism into sensory contact with a much wider environment, and multiplies the possibilities of satisfying its needs and appetites. Without the distance senses an organism would need to rely upon the immediate environment for its food, or discover it by chance in aimless wandering. Some writers maintain that distance sensitivity constitutes one of the favorable conditions for the development of any high degree of mental activity. In primitive conditions of life, organisms to survive must be organized so as to react immediately and impulsively to contact stimuli. Given the distance senses, immediate responses are unnecessary for survival; overt responses may be delayed in the interest of a more adequate adjustment. Mental activity, as we have noted, consists of a series of processes interpolated between the stimulus and the overt act by means of which the object is more adequately cognized and evaluated in terms of possible modes of adjustment. Naturally the development of any very complex mental operations can occur only under those conditions which permit of the delayed types of response.

Localizing ability is quite essential to adaptive behavior. Intelligent conduct has been defined as the activity of an organism in reference to its environment of such kind as to satisfy its motivating needs and appetites. Successful adjustment to the world of material objects usually involves a reaction in reference to their position in space. Without the ability to sense and react to the position of objects, the adjustive capacity of organisms would be extremely limited; an organism might sense the presence of

food but be unable to discover its location except by chance.

The development of the human sense organs and their special mechanisms enables man to distinguish between and identify an almost infinite number of objects. While the eye contains but six sensory functions, yet these may be excited in various combinations of relative strength, making possible, it has been estimated, some 30,000 sensory distinctions. Visual objects may also be distinguished and identified in terms of size and shape. With the combination of qualitative and quantitative distinctions, the differential capacity of the eye is almost unlimited. The same situation obtains for the other complex senses, especially hearing. Size and shape distinctions are impossible with audition, but the ear contains so many special mechanisms that their excitation in varying combinations furnishes the possibility of distinguishing between a great variety of auditory objects. The various senses may also coöperate in the identification of objects. As has been noted, our ability to distinguish between such a variety of edible substances is based upon the coöperation of touch and smell with taste. The ability to identify separately a multiplicity of objects is such a commonplace fact that its utility is ignored. Let the reader picture to himself the effects upon society if all objects in the world could be sensed but not distinguished one from another.

While admitting that a high degree of sensory capacity is essential for intelligent conduct, some may maintain that a considerable portion of our ability is more or less a luxury and can be dispensed with without detriment. Attention is frequently called to the fact that persons with a serious sensory deficiency like Helen Keller are quite intelligent. Yet picture a society of Helen Kellers wholly

dependent upon its own efforts as contrasted with a social group of normal sensory capacity, living under similar conditions. Helen Keller achieved her intelligent status in spite of her defect and because she lived in, and was aided by, a social group with a normal sensory equipment. In fact, human progress has been limited by an inadequate sensory development. Man's understanding and mastery of the world have been greatly aided by the invention of special instruments to increase and extend his sensory ability. Witness the use of microscopes, thermometers, telephones, telescopes, microphones, and various other devices designed to render sensibly apparent certain aspects of the world which would otherwise remain imperceptible.

Motor Equipment. — It is needless to observe that sensory and nervous development would be valueless without a corresponding motor ability. While the number of muscles in the human organism is relatively limited, yet by their varied combination, a great variety of movement is possible. It is usual to ascribe man's superior motor endowment to two factors. One is his vocal or laryngeal ability. Civilization is dependent upon language and intercommunication, and any highly developed language implies a considerable range of vocal capacity. True it is that vocal capacity alone will not insure the development of language, but this ability does constitute one of its essential conditions. Certain it is that man is superior to the animals in this respect with the possible exception of some species of birds. Another distinctive characteristic of man is his manipulative and constructive ability. The whole economic and industrial life of society is intimately dependent upon manual dexterity. Man builds houses, makes clothing, fashions tools, prepares food, etc. With a few

exceptions like the dam-building of beavers and the nest-building activities of birds, animals manifest no constructive ability. Animals for the most part conform their actions to the world, while man transforms this world to suit his own purposes. Man's superior capacity is in part dependent upon the possession of a motor organ nicely adapted to this function. Man's erect posture permits the hands and arms to be devoted exclusively to manipulation. While some quadrupeds use their paws for this purpose, yet their manipulative ability is considerably restricted by their inability to maintain an erect posture and move freely on two legs. Man also possesses the power to oppose the thumb and fingers, — a capacity which renders the hand a most serviceable organ for manipulation. No animal possesses this power. It is doubtful if a society of primitive men devoid of arms and hands could ever have evolved beyond the stage of savagery.

EXERCISES

1. If we grant the existence of paradoxical warmth and cold, how can we explain our ability to distinguish between hot and cold objects?

2. By the use of a nail, a metal knitting needle, or similar object, demonstrate the existence of cold spots on the back of the hand.

3. By the use of a mirror and needle, locate the Kiesow cheek area.

4. Put a drop of a solution of Epsom Salts on the tip of the tongue and compare the taste with that obtained when a drop is applied to the base of the tongue.

5. Develop a negative after-image by fixating a small piece of brightly colored paper steadily for 45 seconds in good daylight illumination. *a.* After developing in this manner, remove the paper without moving the eyes. *b.* Develop as before, and turn the eyes so as to fixate steadily a point on a distant wall.

Keep the eyes motionless until the image appears. *c.* Develop once more, close the eyes and hold them motionless until the after-image appears. *d.* After developing, fixate variously colored surfaces. Note the extent to which the color, size and shape of the after-image are dependent upon the background and to what extent they are a function of the stimulating object.

6. What negative after-images will be obtained from the following stimulating colors — red, blue, orange, purple, blue-green, and yellow-green?

7. What is Hering's explanation of the fact that a color-blind person can see no difference between red, green, and gray objects? Between red, orange, and purple objects? Between orange, purple, blue, and gray objects?

8. State the colors that will be obtained by mixing each of the following pairs of colors in all degrees of relative strength: — Yellow and purple, orange and blue, orange and green, orange and red, and purple and blue.

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CHAPTER IV

SOME PRINCIPLES OF ORGANIC BEHAVIOR

The Reflex Arc Concept. — The nervous system is usually regarded as a conductor. It is a medium for the transmission of energy from sense organs to muscles and glands, a device for translating sensory stimuli into movements of an adaptive character. Three general principles may be deduced from this conception.

All sensory stimuli must exert some effect upon the activity of the organism. Any stimulating condition that affects a sense organ necessarily releases energy, and the only outlet for this energy is the muscles and glands. The validity of this proposition can be tested by experimental means. A subject is requested to remain quiescent, and a number of his involuntary movements are graphically registered by mechanical devices. He is then subjected to various stimuli, — odors, sounds, contacts, etc. Almost without exception, stimulations of this sort produce some noticeable effect upon the character of the involuntary activities in some part of the body. Any very strong and unexpected stimulus as the prick of a pin will produce some effect upon practically every muscle of the body. Other illustrations of the effectiveness of sensory stimuli will be submitted during the course of the subsequent discussion.

All activity, ideational as well as motor, is initiated by sensory stimuli. The sensory-neuro-muscular mechanisms

accumulate and store energy, and this energy can be released only by the incidence of extraneous forces upon the sensitive parts. In other words, neural impulses are not spontaneously aroused. This proposition must be regarded as an assumption, for its validity in the very nature of the case can never be submitted to a decisive experimental test.

Every movement resulting from a sensory situation inevitably modifies that situation, and this change or modification of the sensory situation constitutes a new sensory stimulus which in turn modifies the act that produced it. There is thus a continuous process of interaction between sensory stimuli and motor responses. A stimulus arouses a movement, this response alters the sensory situation, this alteration of sensory conditions constitutes a stimulus that modifies the act, and this new response in turn arouses a stimulus that produces some effect upon the organism's subsequent behavior. Necessarily any living organism must be continually active. The validity of this proposition is easily demonstrated. Kinæsthetic nerves are distributed to all striated muscles, and these sensory nerves are excited by muscular contractions. All movements involve muscular contractions, and these contractures necessarily affect the nerves that are distributed to these tissues. All movements can be directly perceived by means of these kinæsthetic nerves.

All movements of the limbs also involve some excitation of the cutaneous nerves. The skin of the moving parts is usually stretched and flexed by any considerable movement. Walking awakens contact sensitivity on the soles of the feet, while touch is necessarily excited by all movements that involve the manipulation of objects. The kinæsthetic and cutaneous stimuli that are aroused by an

act always exert some influence upon the continuance of that act. In walking, the movement of each leg is excited by the sensory stimuli that were aroused by the preceding movement of the opposite leg. The vocal activities usually excite the ear, and these auditory stimuli may in turn awaken a new vocal response. A person would experience considerable difficulty in talking if he were suddenly to become deaf. A great many movements affect the eye and arouse visual sensations, and these stimulations in turn affect the remainder of the act. For example, the simple act of grasping a visual object can not be performed with any high degree of accuracy when the sight of the moving arm is excluded. All acts that alter the spatial relation of the organism to the objective world necessarily modify the sensory conditions. Most movements will bring new objects into the field of view and exclude others. The intensity of a sensory stimulus is a function of the distance of the organism from the stimulating object. The nearer the object, the more intense is the stimulus. The intensity of all visual, auditory, and olfactory stimuli is necessarily heightened whenever the organism approaches the object.

A sensory stimulus may be defined as any extraneous condition that actually does affect a sense organ. Not all of the physical forces that impinge upon an organism are sensory stimuli. The retina is not sensitive to all light waves. Sound waves of high frequency do not affect the ear. Sense organs are specialized structures that respond to a restricted range of physical forces. Physical forces must possess a certain strength in order to be effective. Sense organs and nerve tissues exhibit a certain degree of inertia, and they do not respond to every increment of energy. Sense organs become adapted to the continuous presence of a physical condition and are no longer affected by it. A

diminution as well as an increment of energy may constitute a stimulating condition. Even the absence of a customary condition may be effective. A person accustomed to the noise and din of a large city may be irritated and oppressed by the quiet of country life. Although we may not notice the ticking of a clock, we immediately detect the fact that it has stopped. In general, changing, novel, and unusual conditions are the most effective stimuli to action.

The doctrine that all sensory stimuli exert some effect upon conduct does not mean that these effects can be readily observed. The inruption of a new stimulus may merely accelerate, retard, or slightly alter the character of the activities in which the organism is engaged at the moment. The effect may be limited to a slight disturbance of breathing or circulation, or the stimulus may merely alter the muscular tensions in certain parts of the body. Not every stimulus arouses a distinctive overt response.

The doctrine that all activity is initiated by sensory stimuli does not mean that the objective environment determines the character of an organism's behavior. In the first place, the energy of the response may be wholly disproportionate to the strength of the physical stimulus. For example, a weak sound may elicit a more vigorous response than a loud one. The nature of the act that is elicited by a stimulus is largely determined by intraorganic conditions, — by the structure and physiological disposition of the organism. No two organisms ever react to a stimulus in exactly the same manner. Neither is an organism wholly dependent upon the external environment for the initiation of its responses, for its activity may be initiated by intraorganic stimuli. For example, hunger, thirst, and internal pains are very powerful stimuli that largely determine

the nature of the organism's reactions. Moreover, every response necessarily alters the sensory situation, and as a consequence the nature of an organism's environmental contacts is to some extent a function of its previous responses. Organisms thus control and regulate to some extent the nature of their environment. For example, man attempts to transform his environment to suit his own purposes. Every organism is to some extent a self-stimulating, a self-controlling, and a self-determining individual. No organism is wholly at the mercy of its objective environment.

The Nature of an Adaptive Act. — Organisms are necessarily active because they are alive and are continually being subjected to sensory stimulations. There is no need to postulate the existence of an ' instinct of activity ' in order to account for the activity of living organisms. So far as the preceding principles are concerned, however, an organism does not need to exhibit an adaptive type of behavior.

An adaptive act involves a motivating stimulus, a sensory situation, and a response that alters that situation in a way that satisfies the motivating conditions. On the other hand, any act elicited by a situation that fails to satisfy the conditions that motivated it is one that is not adapted to that situation. For example, a hungry individual perceives an edible object, reacts to that object and eats until his hunger is satisfied. Hunger is the motivating stimulus. It arouses and energizes the act. Without it, the individual would not react to the food in this manner. The food is the stimulating object toward which the subject's reactions are directed. This object may be termed the incentive, or the immediate objective or goal of the response, and the proper manipulation of this object is the means by which the individual satisfies his hunger motive. A

motive is said to be 'satisfied' when it no longer affects the behavior of the individual. In this case the motive is satisfied when the individual eats until he is no longer hungry. As another illustration we may consider the case of a splinter embedded in one's finger. The resultant pain is the motivating stimulus, while it is the visual situation toward which we react and which we attempt to manipulate in such a manner as to alleviate the irritation. Sometimes the same stimulus serves as both the motive and the goal of a response. For example, a child is frightened by a strange dog and flees to escape its presence. The dog is the motivating stimulus, and the child's response succeeds in altering this stimulus in such a manner that he is no longer affected by it.

A motive is a relatively persistent stimulus that dominates the behavior of an individual until he reacts in such a manner that he is no longer affected by it. Likewise an adaptive response is one that is aroused by a motive and that frees the individual from the dominance of that stimulus. Hunger, thirst, sex, pain, and extremes of temperature are some of the more important and fundamental human motives. The insistent and dominating character of these stimuli is readily apparent. The inruption of such stimuli disturbs and disrupts our activity until their demands are satisfied. The fundamental motives are often called 'organic needs' because their satisfaction is essential to the continued welfare and existence of the organism. These motives are sometimes referred to as the 'drives' or mainsprings to human action, a term that erroneously implies that an individual would cease to act at all without the existence of motives. Motives are not essential to activity; rather they must be regarded as the directive forces that determine what we do, for necessarily we must

react in a manner that is adapted to satisfy these conditions if we are to continue to exist. It is these motives that largely determine the direction of our mental and social development. The character of our civilization and social organization would be profoundly altered, if man were suddenly freed from the necessity of satisfying his hunger and sexual motives (p. 265).

The effectiveness of a motive is not primarily a function of the intrinsic strength of the physical stimulus. For example, the sickly cry of a child will motivate its mother to energetic conduct, and a rare coin or stamp will function as a powerful motive to an enthusiastic collector of such objects. Even pain can not be regarded as an intensive stimulus so far as its physical aspects are concerned. Obviously, the effectiveness of these stimuli is due in large part to the fact that the organism is disposed to respond to them, and we shall refer to these peculiarities of the reactive mechanisms as motivating conditions. These conditions are either congenital or acquired. Congenital conditions account for our responsiveness to pain and hunger, while the disposition of any individual to respond to the sight of a rare stamp has evidently been acquired.

An adaptive response is one that directly affects the stimulating object. Organisms adapt to situations in either a positive or negative manner. A negative response is one that removes the stimulus or lessens its effectiveness. A frightened child flees and escapes the presence of the stimulating object. A person engaged in study is disturbed by a distracting noise and adapts to it by moving to another room where the sound is less audible. A positive response to the stimulating object is one that enhances or continues its effectiveness. A boy hears the faint sound of a band and runs over to the next street to hear it better. An animal

scents food at a distance, runs toward it, and this act enhances the strength of the exciting stimulus. The presence of the food stimulates the animal to eat, and the resultant taste experience is continued by a repetition of the act.

An adaptive act is continued until certain effects are attained that operate to terminate the act. An act may be terminated in one of several ways. 1. The act is discontinued because it succeeds in removing the motivating stimulus. In a negative response, the organism directly affects the motivating stimulus by escaping its presence. A positive response indirectly eliminates the motive through the manipulation of the stimulating object. Pain is alleviated because the splinter is removed from the finger, and hunger is appeased by the eating of food. 2. The act may achieve certain sensory consequences that disrupt the act and initiate a new type of response. For example, the act of grasping a hot object is disrupted by the resultant pain before the act is fully completed. 3. The act is continued until the motivating conditions are so altered that the organism is no longer susceptible to the stimulus. A child in playing with a ball may continue until exhausted. An individual may listen to music until his desire for this type of experience is satisfied. In other words, the act is continued until its motivating conditions are satisfied and the stimulus is no longer effective. Some positive adaptations may be continued almost indefinitely. Certain of the lower organisms are negatively organized in respect to light and positively adapted to a dark environment, and consequently they will remain in such an environment for a long period.

Although an individual can react to any aspect of his complex sensory environment, yet he usually adapts to but one aspect at a time. Individuals sometimes carry on

two activities simultaneously. For example, they may converse with a friend while playing the piano, or answer certain questions while dictating a letter. This type of conduct is the exception, however; a single response is the rule. The unitary character of our responses is due in large part to the fact that the majority of our adaptive reactions involve a movement of the organism as a whole in relation to the external world, and naturally only one response of this sort can be made at a time. Practically the entire musculature of the body is either directly or indirectly involved in such a simple act as putting on one's shoes.

So far we have confined our analysis of an adaptive act to its relation to the stimuli that motivate it and constitute its objective. Any adaptive act is always performed in the presence of a wider sensory environment, and all aspects of this sensory situation will affect the organism and release nervous impulses that must find a motor outlet. Any adaptive response to an object must thus be influenced by and be dependent upon the entire sensory situation of the moment. We may thus say that an organism reacts to the sensory situation as a whole while it adapts to or reacts toward but one aspect of that situation.

These environmental stimuli influence the act in several ways. 1. A stimulus that possesses sufficient motive power may disrupt the act and initiate an adaptive response in reference to itself. Weaker stimuli may function as distractions. Errors and imperfections of adjustment are often due to such factors. Acts that are acquired in one environment can not be performed with any degree of ease and accuracy in novel and unaccustomed surroundings (p. 251). A proficient typist finds it difficult to do efficient work under distracting circumstances. 2. Other stimuli determine

the character of our adaptive responses to the stimulating object. A person's reaction to an orange will depend to some extent upon the environment in which it is perceived. Our reaction to a tiger in a cage will differ from that elicited by this same animal in the open. Other illustrations of this principle will be cited in the chapter on Perception. 3. All adaptive responses modify the sensory situation, and these sensory consequences occur while the act is in progress. Many of these resultant stimuli exert a directive effect upon the succeeding stages of the act. In reaching for an object, the movement of the arm is seen and felt, and on the basis of these sensory data any initial imperfections are corrected before the act is completed. A person would experience considerable difficulty in grasping an object if the arm were totally anæsthetic as well as invisible during the movement. 4. Other stimuli terminate the act. In grasping an object, the act persists until certain contact stimuli are obtained, and the act is terminated because of them. A child in reaching for a flame is burned. The resultant pain sensation did not come after the act was completed, for the act of grasping and manipulating the flame was stopped on account of the pain. An adaptive response is one that is organized to obtain certain sensory consequences, and such an act can not be regarded as having been completed until those results are attained.

All adaptive responses thus consist of a rather complex coördination of sensory and motor elements. All sensory stimuli exert some effect upon the act and practically the entire musculature of the body is either directly or indirectly involved in its execution. Even the simplest type of adaptive response involves a serial organization of elements. The act excites new sensory stimuli while achieving its objective, and these sensory factors are in turn in-

corporated into the act and modify its subsequent development. Some adaptive responses are serially quite complex, and may contain a number of minor adaptive elements. A child will avoid objects in its path, clamber over fences, and open and close doors in its attempt to escape the presence of a frightful object. Obviously the reactions to these objects are subordinate adjustments. They are constituent parts of the larger unitary act for they are motivated by fear and serve as a means for the satisfaction of that motive. All activities that are essential to the satisfaction of a motive are constituent elements of the adaptive response, and it is this complete act that is the unit of behavior.

The Process of Attentive Adjustment. — Practically all adaptive responses of the higher organisms involve two stages, — a preparatory stage of attentive adjustment, and the final or consummatory reaction to the object. These initial adjustments influence the final response in several ways. 1. A novel stimulus may induce a general condition of motor tension and alertness that enables the organism to react in a decisive and effective manner to any emergency that may arise. Such stimuli may also induce a state of motor preparation for some particular type of response. 2. These initial adjustments may influence the final response by increasing the effectiveness of the sensory stimulus. Given a visual stimulus, the head and eyes are turned so as to bring the object into the field of clear vision, the two eyes assume the proper convergent and accommodatory position in order to perceive it distinctly, and the eyes wander over it in order to detect any of its significant details. With an auditory stimulus, the head is turned so as to secure the most favorable position for sensing the nature and position of the sounding object, and the eyes may also

turn so as to coöperate in its appraisal. Similar attentive adjustments may also be observed in the other sense realms. 3. These attentive adjustments promote the efficiency of the response by excluding distractive stimuli. An individual may close his eyes and exclude some visual distraction in order to appreciate a fine passage of music. The stimuli resulting from the intraorganic activities may exert a distractive effect under certain circumstances, and we find that people are accustomed to check their breathing and become relatively motionless while examining some faint auditory or gustatory stimulus. A person often induces a rather general state of muscular rigidity and tension during the performance of a difficult task. The brows are contracted, the jaws are set and the hands are clenched, and it has been suggested that this condition of rigidity may serve to energize the act or to render it less susceptible to the disruptive effects of any distractive stimulations that may arise.

The value of this preparatory stage of adjustment needs no further comment. It is also apparent that these initial activities operate to check or delay the overt response for the time being. The delay may be momentary, or the final response may be inhibited for a considerable period of time. It may also be suggested that these initial adjustments are significant from the standpoint of mental development, for it is obvious that an immediate type of overt response is not conducive to the development of the higher reflective processes.

The Ulterior Consequences of Acts. — In addition to satisfying its motivating conditions, an adaptive response always achieves certain ulterior results, and frequently these consequences are extremely significant from the standpoint of the welfare of the organism. For example,

all acts that satisfy any of the fundamental motives of life are necessarily conducive to the continued welfare and existence of the organism. The act of eating is primarily adapted to the satisfaction of hunger, but it also serves to maintain life. The fact that an act achieves certain valuable results does not justify the assumption that the act was adapted to the attainment of those ends. An adaptive response frequently achieves very beneficial consequences without being influenced in any manner by those results.

The performance of an act can not be legitimately explained in terms of its subsequent effects. We must thus avoid the naive assumption that the ulterior consequences of an act either motivate that act or serve as its objective. Certain larvæ that hatch out at the base of trees are positively organized in reference to the source of light, and as a consequence they crawl up the tree and feed upon its leaves. It can be experimentally demonstrated that the presence of the leaves in no way influences the organism's response to the light. The leaves do not motivate the act or serve as its objective. The larvae do not crawl up the tree in order to attain food. The act must be explained entirely in terms of the animal's organization in respect to the light stimulus. These leaves would need to be either sensed or ideationally apprehended in order to influence the organism's actions. The act of crawling up the tree was not motivated by an idea, for ideas of objects presuppose some previous sensory experience of those objects, and this act was the organism's first response to its sensory world. Neither were the leaves sensed, for these larvæ can not sense their food at such a distance. These organisms crawled toward the source of light, and this adaptive response incidentally brought them into sensory contact with

the leaves, and this stimulus then awakened the food response.

Birds mate, construct nests and incubate their eggs, and as a consequence the young are hatched and reared. Obviously, these consequences can not affect the preceding acts through any sensory avenue, for future events transcend the powers of sense. Prospective situations can influence an organism's reactions only by means of ideas, and these breeding activities are known to occur under conditions that preclude any ideational knowledge of their consequences. These acts can not be explained in terms of their results. Each act must be explained in terms of the immediate situation and the animal's organization in reference to it. It is the eggs in the nest that motivate the incubating act and serve as its objective.

The human mind is also quite prone to rationalize its own acts, *i.e.*, to assume that they are motivated by an idea of their consequences. A person feels a draft and gets up and closes the window. Upon being questioned as to his motives, he may reply that he closed the window in order to avoid catching cold with its attendant ills, while as a matter of fact any such thought never entered his head until the act was completed. In other words, the attainment of beneficial results in the realm of either human or animal behavior does not necessarily indicate that the realizing acts were motivated or influenced in any manner by those results.

An adaptive response must be explained in terms of the reactive disposition of the organism and the stimulating situation in which the act is performed. An individual's reactive disposition is partly inherited and partly acquired during the course of his development (Chap. XV). Unlike some of the lower organisms, man is not endowed with

any very complex and well organized adaptive reactions. An individual's native reaction tendencies must undergo a considerable amount of modification, reorganization, and supplementation before he can react to the world in an effective fashion. This process of organizing and establishing more and more complex and efficient types of response will be described in some detail in the following chapter.

EXERCISES

1. To what extent is the entire musculature of the body either directly or indirectly involved in the act of running to catch a train, in swinging a bat at a baseball, in putting on an overcoat and gloves, in delivering a popular lecture, or in attempting to sell a life insurance policy?

2. To what extent may our reactions to another individual vary according to whether we meet him at his home, at a social event, at church, at a club, at his office, on the street, on a golf course, or in the presence or absence of others?

3. To what extent is the act of running to catch a train influenced by the sight of the ground and the presence of other objects?

4. List a number of environmental circumstances that would probably influence the character of your reactions to the sight of a thousand-dollar bill.

5. Can you study as effectively seated at a table out on the street as you can in the privacy of your own room? Why are our reactions disturbed by all novel conditions?

6. Is the course of your thinking ever determined to any extent by your extraneous surroundings? Illustrate.

7. How does the degree to which the sensory situation and the response mutually influence each other depend upon the sensory and motor development of the organism?

8. How are these complexly organized activities related to the sensory, neural, and motor equipment of the organism?

9. Do organisms, prior to experience, have any knowledge of absent things and conditions, and does this knowledge cause them to strive to attain those things? Is it necessary to postulate the

existence of strivings, desires, and purposes in order to explain the primitive reactions of organisms?

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CHAPTER V

PERCEPTUAL-MOTOR LEARNING

The inability to adapt to a motivating situation constitutes a problem, and the acquisition of a mode of response adapted to that situation is a process of learning. This chapter will attempt an analysis of the primitive method of learning, — that involved in the establishment of an overt adjustment to a sensory situation. For purposes of illustration we shall describe several cases of learning.

A dog has been taught to retrieve a cane. His master throws the cane over a high picket fence. The distance between the pickets is sufficient to permit the dog to pass between them. On being commanded to bring the cane, the dog bounds through the fence, seizes the cane in the middle, and attempts to return. The animal is now confronted with a problematical situation to which he is motivated to respond by his past habits of reacting to master and cane, and the gratification of this motive is dependent upon the discovery of a mode of response that is adapted to the exigencies of this particular situation. The animal now tries out in a random and unsystematic order all of his past methods of dealing with a fence situation. He runs up and down the fence seeking a gate or larger opening, he attempts now one panel and then another, he makes futile attempts to jump over, he attempts to crawl or dig under where the conditions seem to warrant, or at times he will sit on his haunches and beg and whine, — a

method which in times past has been efficacious in escaping from similar difficulties. In these wild scrambles the dog is continually dropping the cane and seizing it again. He finally chances to seize the stick near one end and thus succeeds in carrying it through between the pickets. But this adaptive response is not yet learned. When the test is repeated on succeeding days, the same process of solution is duplicated with the exception that the time involved is gradually decreased with successive trials until the act is finally perfected. The dog bounds through the fence, immediately seizes the cane at one end and returns without unnecessary delay. The problem is now mastered and a new adaptive response has been perfected.

A hungry rat is confronted with food placed within a small wire cage. The floor about the cage is covered with sawdust. At one end of the cage is a small door which will swing open when a wooden lever is lifted from its catch. To enter the box the rat is compelled to learn the trick of lifting this latch with its nose. Motivated by hunger and the odor of food within the box, the animal tries out all of its previous modes of dealing with obstructions to food. It attempts to nose its way through the openings of the wire mesh, clambers all over the box in the search for a larger opening, digs at various places in the sawdust, and attempts to gnaw through the wires. While frantically working near the latch, a chance movement of the head happens to release it, and the rat gains access to the food. In the succeeding trials the same process is repeated with the exception that the time of entrance is gradually shortened until the animal is able to open the door immediately without making any unnecessary movements.

The maze problem is frequently employed in studying

this type of learning. A maze consists of a food box and a connected system of runways whose dimensions are adapted to the size of the animal. A typical pattern is represented in Figure 24. The animal is placed in the maze in the position indicated by the arrow. In its explorations, the animal wanders around somewhat aimlessly, but keeps making wider and wider excursions and in time happens to reach the position of the food box and secures food. In the subsequent trials the same procedure is repeated but the number of unnecessary movements is gradually decreased until finally the animal runs directly to the food box without retracing its steps or entering any of the blind alleys.

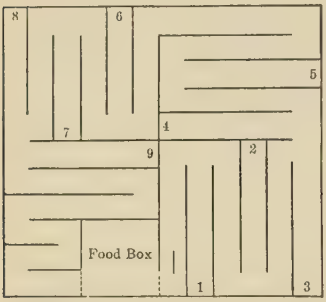

Fig. 24 — A typical maze pattern.

A stylus maze is employed with human subjects. Small slots are milled in a brass plate, and the subject is required to move a metal stylus through this system of grooves. Upon reaching the position of the food box, the metal stylus completes an electric circuit and a buzzer is sounded. The subject is thus confronted with the task of exploring these grooves until the position of the buzzer is discovered. Necessarily the subject must be blindfolded or the maze be placed behind a cloth screen in order to exclude the possibility of visual guidance. The method of learning is practically identical with that employed by animals. There is a random exploration with a chance success, and the unnecessary movements are gradually eliminated during the succeeding trials.

These examples illustrate three essential features of the

learning process. The organism is confronted with a problematical situation to which it is motivated to respond. The problem is solved by means of a variable and analytical motor attack which persists until the successful act is discovered by chance. The final stage is the process of fixation and elimination. The wrong acts are gradually eliminated and the correct response is more firmly established during a series of repeated trials. We shall discuss these three aspects of the learning process in order.

The Problem. — Problems are due to a lack of adjustment between an organism's motivating needs, its immediate environment, and its reactive equipment.

1. The environmental means of satisfying motives may be lacking, and these objects of satisfaction must be discovered or created. Practically every organism is confronted with the problem of finding food.

2. Environmental obstructions are encountered and these obstructions must be circumvented in some fashion. For example, man builds bridges, drains swamps, and tunnels mountains as a means of satisfying his various motives.

3. An organism may lack the requisite motor ability to react to a situation. For example, the human infant is incapable of satisfying its needs under the most favorable environmental circumstances.

4. A conflict between two mutually exclusive tendencies also constitutes a problematical situation. An organism may possess several antagonistic modes of responding to the same object, such as curiosity and fear in the presence of a novel situation. An organism may be subjected to the opposing influences of two stimulating objects, — each tending to elicit an appropriate response. The nesting bird may be swayed by the impulse to incubate her eggs and her fear of the approaching intruder. Problems of conflict neces-

sarily multiply with mental development. The extent to which man is subject to this type of problem will be more adequately discussed in the subsequent chapter on Reasoning.

The greater the number of problems that confront an organism, the greater are its opportunities for intelligent development. Organisms differ considerably in this respect. With the lower organisms, there exists a nice adjustment between their motivating needs, their environment, and their motor ability. Their needs are few and simple, and they are capable of being satisfied by the immediate environment. These organisms also come into the world endowed with a ready-made ability to respond successfully to their environmental conditions. There is but little opportunity or necessity for such animals to learn. The human child, on the other hand, is born with more needs, and some of these can not be satisfied by the immediate environment. Moreover any effective motor ability is practically lacking at birth. Life to a child consists mainly of a series of problems, and its continued existence implies parental care, training, and mental development.

Writers have frequently noted and commented upon the fact that there exist several parallel lines of development as we ascend the zoölogical scale.

1. Organisms exhibit an increasing degree of helplessness at birth. Of all organisms, the human child is the most helpless at birth.

2. There is a corresponding lengthening of the period of youth and growth. Some exceptions occur, but the law holds in the main.

3. There is an increase in the amount of parental care bestowed upon offspring.

4. We likewise find an increase in the intelligent capacity

of organisms. It has been suggested that this evolution of intelligence is conditioned upon the first three factors. Without parental care, this initial helplessness would be fatal to survival. The youthful organism is protected until its lack of ability to care for itself is remedied by experience, and youth is primarily a period in which to acquire this experience and training.

The Solution. — The problem is solved by means of a variable, persistent, and analytical motor attack in which the organism tests out all those modes of behavior that have been of service in meeting similar situations in times past. The hungry rat tries out all its established ways of securing food, and the dog brings to bear upon the problem all of his previous methods of dealing with a fence situation. In solving a problem, organisms thus react in a manner that is relevant to the situation, for the world is so constituted that acts that are adapted to one situation are usually somewhat appropriate to similar situations.

Writers sometimes over-emphasize the random and aimless character of the animal's behavior. Organisms never react to a problem in a wholly random and aimless fashion, for their mode of attack is always relevant and appropriate to the situation to which they are attempting to adjust. In fact, any given problem can be solved only in so far as the organism employs an attack that is relevant to that particular situation. An aimless type of reaction will never achieve success. Organisms exhibit a random and unsystematic mode of attack only in the sense that the exact order of procedure can never be predicted.

Neither is the discovery of the solution wholly a matter of chance. Things are said to happen by chance only in so far as their occurrence can not be predicted or foreseen. An animal can solve certain problems and not others. In

order to be solved, a problem must be adapted to the capacity of the organism. For example, a rat can not learn to open a box by turning a key in a lock although this problem is well within the range of the motor capacity of a monkey or a child. As a general rule we may say that an animal will solve any problem that lies within the range of its capacity provided that it is sufficiently persistent in its efforts. It is the exact time that is required to solve a problem that can not be predicted. A given animal may attain success in two minutes, in twenty minutes, or after five hours of strenuous endeavor. The discovery of the solution may be characterized as a matter of chance only in so far as the time of its occurrence can not be predicted.

The variability of the attack is due primarily to the effect of the organism's movements upon the sensory situation. The wrong or futile attempts generally produce stimuli that inhibit the act or discourage its repetition. The sensory effects of gnawing at the wire mesh are not conducive to a continuance of the process. Digging in the sawdust is not long continued when the hard floor is reached. The dog soon ceases his attempts to jump over the fence after a few disastrous failures. Each act brings the animal into a new relationship with the sensory situation, and as a consequence some new sensory aspect of the problem is continually confronting the animal and directing its energies. The organism never reacts to the complex situation as a unit. It reacts to the situation in a selective and analytical manner, *i.e.*, it adapts first to one aspect of the situation and then to another. For example, the rat first reacts to the sawdust, then attacks the wire mesh, and finally centres its energies upon the wooden latch. The animal thus exhibits a variable and analytical mode of attack.

Inasmuch as the time required to solve a problem is largely a matter of chance, it is evident that the success of any individual is dependent in part upon his persistence and perseverance. As we have indicated, an organism will solve any problem that is adapted to its ability if it is sufficiently persistent in its attempts. Organisms differ considerably in respect to this trait. Some animals will work frantically with but little interruption for an hour at a time. Others work less vigorously and rather intermittently, while some will quit after a time and refuse to work further. Persistence is a function of several factors: — One is the strength of the motive. A very hungry rat will work much longer than one whose appetite has been partially appeased. Some foods will excite more persistent efforts than others. A hungry rat will work longer to attain food than it will to return to the companionship of its mates. Persistence also varies with organic vigor. A vigorous, healthy, well nourished animal will work more industriously than a poorly nourished one. Perseverance is also influenced by past successes and failures. A rat that has failed in several attempts at a problem will rarely succeed in subsequent trials. The human infant manifests the same tendency. A child, accustomed to having its own way, soon learns the value of persistency in attaining its desires. Success breeds confidence, and confidence is conducive to persistent efforts.

The likelihood of solving a problem is also conditioned upon the degree of variability manifested in the attack. Within certain limits, the more varied the attack, the more likely will the solution be discovered. The variability of attack depends in part upon the wealth of relevant activities that an organism is able to bring to a problem. Variability also depends upon the complexity of the problem and the

sensory and motor equipment of the organism. An animal varies its response to a situation because each movement alters the sensory situation, and this is possible only when the organism reacts to the problem in a discriminative and analytical manner. Organisms differ widely in respect to their variability of behavior. Variability, like discriminative sensibility, increases as we ascend the zoölogical scale, and it is generally assumed that the greater variability of the higher organisms constitutes one of the essential conditions of their greater intelligent capacity.

Fixation. — The correct response is fixated and the wrong acts are gradually eliminated during a series of repeated trials. Various explanations have been proposed to account for this fact.

Let us assume that the animal brings to the problem six distinct modes of attack which we shall refer to by the letters A to F. We note the fact that the act F is finally fixated. We now raise the question why act F was fixated and the other acts were eliminated. There is but one answer to this question. Obviously the act F was fixated because it was successful and the other acts were eliminated because they were unsuccessful. It is also evident that successful and unsuccessful acts can be differentiated only in terms of their consequences, *i.e.*, in terms of the effects that they exert upon the stimulating situation. A successful act is one that alters the problematical situation in such a manner as to satisfy the conditions that motivated the animal to respond to that situation, while the unsuccessful acts are those that do not achieve such a result. For example, the successful response to the latch box problem is the one that attains food and alleviates hunger, while the unsuccessful responses are those that fail to attain this end. In other words, the fixation and elimination of acts must be

explained in terms of their consequences. This fact is usually referred to as the Law of Effect.

The distinctive effects that operate to fixate the successful response and to eliminate those that are unsuccessful have been variously defined. For example, it has been suggested that the successful acts are fixated because they attain pleasant, satisfying, desirable, beneficial or reinforcing effects, while the wrong responses are eliminated in virtue of their unpleasant, dissatisfying, undesirable, detrimental, or inhibitory consequences.

According to the first conception, pleasantness and unpleasantness are regarded as two observable items or aspects of experience. It is assumed that the organism's responses alter the sensory situation, that the resultant sensory stimuli awaken these affective processes, and that these processes in turn influence the retention of the acts of which they were the consequents. Pleasure resulting from an act is said to ' stamp in ' that act, while the wrong acts are eliminated by their unpleasant consequences.

The last conception assumes that acts are fixated or eliminated in virtue of their sensory consequences. All acts alter the sensory situation, and the sensory stimuli necessarily exert some effect upon the subsequent behavior of the organism. Successful and unsuccessful acts can be differentiated on the basis of these effects. In the first case, the resultant sensory stimuli tend to reinforce, direct, and continue the act until the objective is attained, while the sensory stimuli resulting from an unsuccessful act operate to inhibit, disrupt, and discontinue that mode of attack. For example, a rat soon desists from further digging when the hard floor is reached, and the sensory results of gnawing at the wire mesh are not conducive to a continuance of this mode of attack. On the other hand, the sensory con-

sequences of a successful act function to direct that act to the attainment of its objective. The rat lifts the latch, the open door entices the animal to enter, the rat approaches the food and begins to eat, and this act of eating is then continued until the animal's hunger is appeased. In fact, the continuance or discontinuance of any line of attack is almost wholly a function of the character of the sensory stimuli that are encountered during this time. This conception now assumes that the reinforcement of an act is conducive to its subsequent arousal, while the disruptive and inhibitory effects of the unsuccessful acts weaken those tendencies and prevent their rearousal on some subsequent occasion. The nature of the neural mechanisms involved is a speculative matter, concerning which opinions may differ.

The terms satisfaction and dissatisfaction may be defined in two ways. An experience may be regarded as satisfactory because it is pleasant, or the term may be used to denote the alleviation of a motivating condition. For example, the rat opens the box and secures food, and this act of eating may be said to be satisfying because of the pleasure involved, or because the act appeases or 'satisfies' the animal's hunger. This conception thus involves no new explanatory principle, for the fixation and elimination of acts must be explained in terms of their affective or sensory consequences.

Undesirable results are those that normally elicit an avoiding reaction, while desirable consequences are those that an organism strives to attain. A successful act is thus one that attains a desirable result. We may thus say that an act is fixated because it is successful or because it attains a desirable result. The use of this term involves no new explanatory principle.

It is quite obvious that the superfluous activity involved in solving a problem can not be regarded as detrimental to the health and continued welfare of the organism. All wrong acts can be characterized as detrimental only in the sense that they are unsuccessful, and the right act is beneficial because it is successful. In other words, the terms beneficial and detrimental are employed as synonyms for success and failure respectively. Neither do these terms involve a new mode of explanation.

The fixation of acts must thus be explained in terms of either their affective or their sensory consequences. The general nature of the affective aspects of experience and their function in mental life have been discussed at length in Chapter XIII, and the doctrine that these two items of experience exert a causal influence in the initial establishment of our adaptive modes of response has been rejected on both factual and theoretical grounds. Inasmuch as the reader may refer to this discussion, we shall not attempt to summarize the argument at this point.

Two objections have been urged against the Law of Effect. In several experiments, it has been shown that the subject continues to improve with practice although he has no knowledge of this fact. The effects of any act, however, may modify that act even though the subject may have no knowledge concerning them. For example, in the stylus maze subjects often make errors and eliminate them without knowing anything about it. Knowledge of the consequences of an act is not an essential condition of their effectiveness.

It is maintained that the consequences of an act are experienced after the act is completed, and hence that it is illogical to assume that these factors can causally influ-

ence what has preceded them. This argument is fallacious in two respects. As we have previously indicated, these sensory consequences occur during the performance of the act. Each wrong response is continued until certain sensory results are encountered, and these sensory stimuli operate to terminate the act. The sensory results occur during the continuance of the activity, and the act is then terminated on account of them. The rat runs toward the food and bumps into the wire mesh. The bump is experienced while the rat is running and these sensory consequences are responsible for the discontinuance of the act. The child grasps a flame and this activity is terminated because of the resultant pain. Finally, the theory does not assume that these sensory consequences influence that portion of the act that preceded them. It merely assumes that they do affect the subsequent retention and functioning of the act. As developed in another chapter, the process of fixation is continued on an unconscious level for some time after the performance of an act. The sensory consequences of any activity can thus readily interfere with this subsequent process of fixation.

The influence of the sensory consequences can be experimentally demonstrated. The maze has been so wired that the animal will receive an electrical shock whenever it enters a blind alley. Under these conditions, entrances into these portions of the maze are eliminated much more quickly than under the usual conditions. Evidently, the additional stimuli resulting from these reactions have played some part in the elimination of those responses. Let us assume that the food, after several trials, is placed in alley 9 rather than in the food box (Fig. 24). The act of entering this alley will now become established rather than

eliminated. Obviously, the fixation or elimination of the act of entering any blind alley is a function of the character of the sensory consequences that are encountered in so doing.

A final theory explains the fixation and elimination of acts on the basis of the relative frequency of their occurrence. Three assumptions are involved. 1. The theory assumes that each of the series of acts that are elicited by any problem is strengthened or fixated in proportion to the number of times it is repeated. 2. The successful act in the nature of the case occurs once in every trial. As a consequence of this fact, it is asserted that in any very extensive series of trials the successful act will be repeated more frequently than will any of the wrong responses. In other words, the successful act will develop in time a greater functional strength than that of any of the unsuccessful modes of response. 3. It is now assumed that the temporal order in which the various responses are elicited is to a large extent a function of their relative strength. In time the correct response will attain such a functional strength that it will be elicited immediately whenever the organism is confronted with the problem. Obviously none of the wrong responses will appear under these circumstances, and the problem can now be regarded as mastered. According to this conception, the erroneous modes of reaction are not eliminated in the sense that they are either weakened or eradicated. They are merely repressed or prevented from functioning in that situation by the more prepotent and successful response.

Three criticisms of this theory may be suggested.

1. Let us grant the assumption that the successful response is repeated the most frequently during an extensive

series of trials. What is the explanation of this fact? It is quite obvious on a moment's reflection that the more frequent occurrence of the correct response is due in part at least to the fact that the wrong acts are gradually being eliminated during this time. In other words, it is the elimination of these acts that accounts for their more infrequent appearance, while the theory reverses this causal relationship and assumes that their infrequency is responsible for their elimination.

2. The theory assumes that the elimination of the wrong responses is an incidental result of the firm establishment of the successful act. According to this assumption a problem will be most readily solved when the appearance of the wrong acts is prevented by some means. This hypothesis has been tested with the use of the stylus maze. By verbal and manual means, all retracings and entrances into the blind alleys were prevented. In other words, the subjects were enabled to traverse the maze without error. The subjects were informed of the purport of the experiment, and they were instructed to use their best efforts in the attempt to fixate the correct response during these trials. After a variable number of such trials, the subjects were tested for their ability to traverse the maze without guidance. No one learned the maze during these guided trials; in fact, too much guidance was actually detrimental. In other words, a certain number of errors must be made and eliminated before the subject is ever able to run the maze correctly. Correct modes of response are established in part by learning what not to do. Fixation and elimination are mutually related processes. Undoubtedly the fixation of the correct response is partly responsible for the elimination of the errors, but it is equally true that the establishment of the correct mode of response is an inci-

dental result of the eliminative process. The fact of elimination can not be explained exclusively in terms of fixation.

3. The assumption that every repetition of an act operates to strengthen and fixate that act can not be accepted. As we have just seen, elimination is to some extent an independent process. In other words, the sensory consequences of an act may be such as to disrupt and weaken that act, and in so far as this is true we may say that the more frequently the act is repeated, the more quickly it will be eliminated.

The unsuccessful responses to a problem are not eradicated from the organism's repertoire of reactions. They are merely eliminated so far as that particular situation is concerned. An act that has been eliminated for one situation may nevertheless be utilized effectively in solving other problems. It thus follows that the unsuccessful acts may become so reëstablished by subsequent practice that they will once more appear when the organism is confronted with the problem at some subsequent time. In other words the solution of the problem has been forgotten in the meantime. This fact illustrates the general principle that the ability to retain that which has been learned is to some extent a function of what the organism does during the interval between learning and recall.

Transfer. — As noted, an organism solves a problem by trying out all those modes of response that have been of service in dealing with similar situations in times past. This process of utilizing previous modes of reaction in dealing with new situations is called transfer. What an organism learns in solving one problem will thus be utilized later in dealing with similar situations. In solving any problem, an organism thus acquires a mode of reaction that is adapted

to a great variety of situations. In solving the fence problem, the dog acquired the knack of carrying any cane or any similar object through a fence. This process of automatically applying the fruits of a particular experience to new situations is a primitive, fundamental, and invaluable characteristic of mental activity. A child when severely frightened by its first experience with a dog will thereafter be afraid of all dogs until this tendency is corrected by further experience. When a child learns the name of a particular object, it immediately applies this name to all similar objects.

This trait is quite valuable from the standpoint of rapid progress in mental development. Think of the enormous amount of time and effort involved in the acquisition of language, if we were forced to learn separately the name of each individual object. A child often makes very amusing mistakes in applying what it has learned to new situations. For example, a child may in all seriousness refer to a table's knee, or use the word papa somewhat indiscriminately. These mistaken applications should not blind one to the value of the tendency, for these erroneous applications are soon corrected in the give and take of experience. As a matter of fact, the principle involved in this process is a sound one, for similar objects as a rule do demand a similar mode of treatment. Our later acquired powers of rational generalization find their origin in this process, for in generalizing we merely attempt to formulate and state in explicit terms the range of prospective situations to which any solution is applicable (p. 212). Organisms thus do not learn to generalize; rather they learn by experience to check and control this primitive tendency of indiscriminate application. The old adage of 'not jumping to conclusions' is sufficient proof of this fact.

All learning thus involves the use of our previous experiences. What an individual can learn is a function of what he has learned. We must learn to stand erect before we can learn to walk, and the ability to walk is a prerequisite to the acquisition of a great variety of perceptual-motor habits. No one can learn to typewrite without first acquiring the ability to read and move the arms and fingers in a coördinated fashion. The acquisition of all new acts thus involves some sort of a reorganization of the data of our previous experiences. Learning may be defined as a process of modifying or reorganizing our customary modes of procedure in such a way as to enable us to react successfully to novel situations. No complex act is ever learned at once. Beginning with our congenital repertoire of movements, each complicated act is gradually built up bit by bit in the manner we have described. Every act may thus be regarded as having a long and complicated genetic history.

All perceptual-motor modes of adjustment are acquired in this manner. The method is employed by all organisms. All animals can learn to some extent, and this is the method they invariably employ. For this reason, it is sometimes referred to as the animal method of learning. Its use is not confined to animals however. Man also employs this method in learning to walk, talk, write, dance, and swim, and in acquiring all those manual habits that are involved in the manipulation of objects. It is the method of ' learning by doing ' as contrasted with those methods that involve the use of ideas. The motor method is the primitive and fundamental method of learning. It is the only method that can be employed in the early stages of mental development, and it is the method from which all other types of learning are derived. Its use, however, is not confined to the early stages of mental development. Adults invariably revert to its use

whenever a rational solution of a problem is impossible. There are certain problems that can be solved in no other way (p. 191).

Association. — Any two items of experience are said to be associated whenever they are organized in a stimulus and response relation, *i.e.*, when the presence of one will stimulate or arouse the other. Any adaptive activity may be regarded as an associated sequence of analytical elements, for any part of this act is a stimulus to that which follows, and conversely any part is a response to that which preceded.

Learning may now be defined as a process of establishing such associative connections, — of organizing the items of experience into larger functional units. For example, the dog established an associative connection between the sight of the cane and the act of grasping it at one end, and the rat learned to associate the act of lifting the latch with its sensory experiences of this object. A child in learning to walk associates the movements of the two legs in such a manner that the sensory experiences resulting from the movement of one leg serve as a stimulus in arousing a response on the part of the opposite limb. A somewhat similar associative sequence is the finger run of a pianist. Likewise in learning to read, a child establishes a system of associations between certain visual symbols on the one hand and his experiences with objects on the other. In other words, the child becomes so organized that the presence of one of these visual symbols will arouse a thought of the object in question.

There are certain laws of association that purport to describe the various uniformities that obtain in the sequence of mental events. The law of similarity states that the thought of one object is likely to arouse a thought of a

similar object. According to the law of contrast, the thought of any given object is apt to make us think of some contrasting notion. White and black, up and down, large and small, good and bad are examples of such concepts. Likewise we may say that the thought of an attribute is apt to suggest an object to which it belongs, that the thought of a relation is apt to suggest some related terms, and that the thought of an act is likely to suggest some object that is usually connected with that act. The value of such formulations may be questioned. Such laws merely describe the sequence of cognitive events, *i.e.*, of perceiving and thinking of objects. They are not applicable to the sequences of other types of experience such as the movements involved in walking, swimming, and playing a musical instrument. Moreover, as many laws are possible as there are logical relations, and hence any given sequence of ideas may be described in several ways.

There are two explanatory laws of association, — contiguity and assimilation. These laws purport to state the conditions under which these associative connections are established. The law of contiguity may be stated as follows: — Whenever two mental events are experienced together or in immediate succession, they thereby become so related that thereafter the presence of one will tend to arouse the other. However, these conditions must be frequently repeated in order to establish any very effective connection between the two acts. For example, the dog necessarily sees the cane at the same time he grasps it at one end, these two acts of seeing and grasping thereby become connected, and this associative tendency is gradually strengthened as these conditions are repeated in the subsequent trials. The rat senses the latch when he lifts it with his nose, and these two acts are associated because they are

simultaneously experienced. Likewise, the teacher establishes an associative connection between the perception of a visual symbol and the thought of a given object by inducing the child to perform these two acts simultaneously. Contiguity is thus an essential condition to the formation of an association. Obviously, no child would ever establish such a connection if it perceived the symbol at one time and thought of the corresponding object on the day following.

The nervous mechanism involved in the formation of these associations was described on page 37. The rat developed the habit of turning around and retracing its path in response to an electrical stimulus. The experimental conditions were now so arranged that the rat heard the sound of a bell at the time it reversed its path, and in time these two acts became so associated that the perception of the sound aroused the retracing response although the electrical stimulus was no longer given. The nervous system consists of a complicated system of interrelated conduction tracts. The direction in which an impulse is transmitted at any centre is to some extent a function of the state of activity of all other parts of the nervous system. The nervous system thus acts as a unit. All simultaneous activities necessarily interact upon each other and become organized into a complex unit.

An effective and enduring association will be established only between those mental events that are experienced together with some degree of frequency. Roughly speaking, we may say that there are three general conditions that determine the character of our associations.

1. Every organism must necessarily acquire in the manner we have just described a system of perceptual-motor associations that are adapted to the satisfaction of its

motivating needs and appetites. The nature of these associations will vary with the type of organism and the character of its environment.

2. As we have previously noted, all aspects of a sensory situation exert some influence upon and hence become associated with the organism's reaction to that situation. In other words, all objects that are frequently experienced together must necessarily become indirectly connected in virtue of the fact that they are associated with the same response. All natural conjunctions and sequences of objects and events must necessarily become associated with each other in time. For example, every individual must necessarily acquire a system of topographical associations. An association will be established between the sight of a person and the sound of his voice. The flash of lightning will be associated with the sound of thunder, and the appearance of heavy clouds will naturally suggest the thought of rain.

3. Certain associations are also imposed upon us by society. For example, a certain prescribed system of associations is imposed upon a child when it is taught to read and write. In fact, society imposes a given set of associations upon the members of each new generation just in so far as it attempts to guide the character of their mental development.

A child learns the name of a given object and automatically applies this name to all similar objects. This application of the fruits of past experience to new situations has been termed a process of transfer. Conversely, each new object elicits those responses that have been associated with similar objects in times past, or we may say that our experiences of all new objects are invariably incorporated into those systems of experience that have been developed

in dealing with similar objects. This phenomenon is termed the Law of Assimilation, and it nicely accounts for the fact of the associative connections that obtain between similar objects. In other words, all similar objects are indirectly connected with each other in virtue of their direct association with a common response.

The Concept of Habit. — An established system of associations is said to function in an automatic and habitual manner. Acts differ in their habitual strength. The more habitual an act, the longer it will be retained. The more established the act, the greater is the ease and facility and the accuracy with which it is performed. All aspects of the behavior situation exert some effect upon the performance of an act. Many of these stimuli tend to inhibit, distort, and disrupt the act, and prevent the attainment of its objective. All novel circumstances are likely to induce some such effect. A rat that learns a maze in one situation usually makes a number of errors when it is required to run that maze under different environmental conditions. A college teacher may acquire the ability to lecture to his students with precision, ease, and confidence, and yet be unable to deliver the same lecture with any degree of readiness and precision to a strange audience. The more habitual an act, the more readily and accurately it can be performed in novel surroundings. Habit thus firmly welds the constituent parts of an act together, gives it greater coherence, and isolates it from the distractive influences of novel surroundings. The more habitual an act, the more easily it will be excited, the more likely it is to be repeated from time to time in an identical fashion, and the more likely it is to attain its objective without error. We may thus speak of our thoroughly engrained or stable habits as opposed to those of a more plastic and flexible character.

The stability or strength of any act is a function of a variety of circumstances. Four of these may be briefly noted in this connection.

1. All other conditions being constant, the strength of an act is proportional to the number of times it has been performed.

2. The strength of an act is a function of the character of the environmental conditions under which it is performed. Repetition under relatively constant environmental conditions is essential to the development of a highly stabilized act. The performance of an act under rather novel and distractive conditions may seriously retard its development. Variable conditions are conducive to the development of a flexible mode of response, for the act must be continually modified to meet those variable conditions. For example, the length and character of one's step in walking must acquire a certain degree of plasticity in order that it may be adapted to the variable exigencies of the environment.

3. Any adaptive activity is quite complex, and necessarily many of its constituent elements must constitute a part of other organized activities. It has been suggested that the continual use of the components of any act in other associative sequences will tend to preserve the plastic and flexible character of the activity.

4. The functional strength of an act must be considered in relation to that of any alternative mode of response. In the solution of a problem, the successful act can be regarded as established only in so far as the unsuccessful acts have been eliminated, and as we have noted the practice of these acts in other situations may operate to prevent the organism from responding correctly when the problem is again encountered.

In spite of the ease, speed, and precision with which it may be executed, an inflexible type of response is not adapted to all situations. A relatively plastic act is better adapted to some circumstances. A rigid and inflexible mode of response is serviceable in adapting to relatively stable and constant conditions, while a more flexible and plastic act is demanded in adjusting to all of the variable conditions of life. The doctrine that all acts should be so thoroughly established that they can be executed in a highly automatic manner is just as absurd as is the dictum of Rousseau, *viz.*, that education should inculcate but one habit, and that the habit of not forming habits.

EXERCISES

1. Can you cite any human adaptive reactions that have not been partly learned?
2. List ten human activities that have been acquired by the motor method.
3. In what respects does the motor method of learning conform to the definition of mental activity as given in Chapter I?
4. Under what sorts of environmental conditions have the great civilizations developed? Can you suggest any explanations?
5. Is the animal's discovery of the solution a matter of chance from the standpoint of the animal, the experimenter, or both?
6. Are such traits as ingenuity, resourcefulness, originality, initiative, and inventiveness genetically related to motor variability? Can an organism be too variable and erratic?
7. Show that variability and the law of effect illustrate the reflex arc concept as stated in Chapter IV.
8. Do children make any more mistaken applications of what they have learned than do many scientists in their rational generalizations?
9. Show that every act of learning involves a new organization of the items of experience.
10. Is it theoretically possible to establish types of association that will seriously interfere with your ability to react

successfully to a given situation? Illustrate with ten hypothetical examples.

11. Is our success in life more or less dependent upon the character of our experiences than it is upon the way these have been organized?

12. Why must all individuals establish certain common associations?

13. Are contrast, similarity, and contiguity coördinate laws of association?

14. Is some sort of motor response essential to the establishment of an association between two objects?

15. Is there any relation between the fact of association and the existence of associational neurones?

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CHAPTER VI

PERCEPTION

A process of perception is involved in most acts of adjustment. Perception may be defined as the cognition of a present object in relation to some act of adjustment. An act of perception involves a stimulating situation, a preliminary attentive adjustment toward it, and the arousal of its meaning or significance for what we are doing or in reference to some contemplated mode of reaction. We shall discuss these three aspects of the perceptual process in order.

Perceptual Objects. — Any sensory situation may constitute an object of perception. Beginning students occasionally assume that they perceive objects only when they *see* them. As a matter of fact we may perceive objects through any sense or various combinations of senses. Listening to sounds, smelling odors, tasting foods, testing the temperature of water with the hand, as well as looking at a picture or a landscape are perceptual activities. We may perceptually identify the nature of some edible substance in the mouth through the combined aid of taste, smell, and contact. Sight and hearing may coöperate in the perception of a vibrating object, while we can perceive our movements in walking in terms of vision and kinæsthetic sensitivity. Perception is not limited to things of the objective world. All organic conditions are potential objects of perception. Watching or feeling our own movements,

listening to the sound of our voice, observing the beating of our heart, noting some muscular twitch, and examining the nature of some intraorganic pain are all perceptual activities. Kinæsthesis and intraorganic sensitivity may be involved in perception as well as sight and hearing.

According to our definition, a perceptual object does not necessarily involve the presence of an objective material stimulus. For example, a negative after-image can be perceived. The process of observing the behavior of a negative after-image differs in no essential respect from the observation of any objective event. Joan of Arc heard voices as though some one were speaking to her. These auditory experiences are termed hallucinations or false perceptions because she misinterpreted their significance for further conduct. According to our definition, these sounds would still have been perceived if their significance for conduct had been correctly apprehended. The apprehension of any constituent item of experience as a potential object toward which to react is an act of perception.

A perceptual object usually involves an organized group of sense data. This fact is quite obvious when we perceive a landscape scene, a herd of cattle, or a flock of birds. Relatively simple objects like a tree or a book also exhibit a certain amount of sensory complexity. Objects are necessarily complex in so far as they stimulate several senses. A vibrating string is both a sounding and a visual object. Our perceptual experiences of food are usually composed of tactual, kinæsthetic, temperature, and olfactory elements as well as those of taste. A thermal stimulus excites contact as well as warmth or cold. As noted in a previous chapter, every light stimulus awakens more than one of the elementary color processes. Even the most pure colors like those of the spectrum contain a certain amount

of gray. Every auditory stimulus excites a series of overtones or partials in addition to the dominant or fundamental tone. This phenomenon is due to the fact that vibrating bodies, a piano string for example, vibrate in halves, thirds, fourths, fifths, etc., as well as a whole, and each of these partial vibrations awakens a corresponding tonal element. Practically all perceptual objects are complex.

The organized character of the sensuous data is a product of previous experience. In a puzzle picture, all of the lines that represent the hidden object are visible but the object is not perceived because these lines are perceived as constituent parts of other objects. A new organization of the sensuous data is essential to the perception of the hidden object. Even if the spacing between the words of a printed page were lacking, a person would still perceive combinations of letters or word units. This organized way of reacting to the printed page is obviously a matter of habit. A foreign language when first heard is a mere jumble of strange sounds. As these sounds become associated with the individual's experiences while the language is being mastered, the character of the auditory experience is profoundly altered. The sounds are now perceived in an organized fashion. The spatial organization of sensuous data is also largely a matter of habit. The fact that the auditory and visual experiences that are aroused by a given material stimulus are regarded as aspects of the same object and are perceived in the same location must be explained largely in terms of previous experience.

In Figure 25, the stairway may be perceived from above or beneath. Either six or seven cubes may be perceived in Figure 26. The spatial arrangement of these diagrams can thus change although the objective stimulus is a constant.

The two diverse perceptions of the same objective fact must be due to a difference in the observer's attitude toward it. It is also well to note that in neither case do we see the object as it is. The diagrams present a flat surface while we perceive them as tri-dimensional. The same fact is ex-

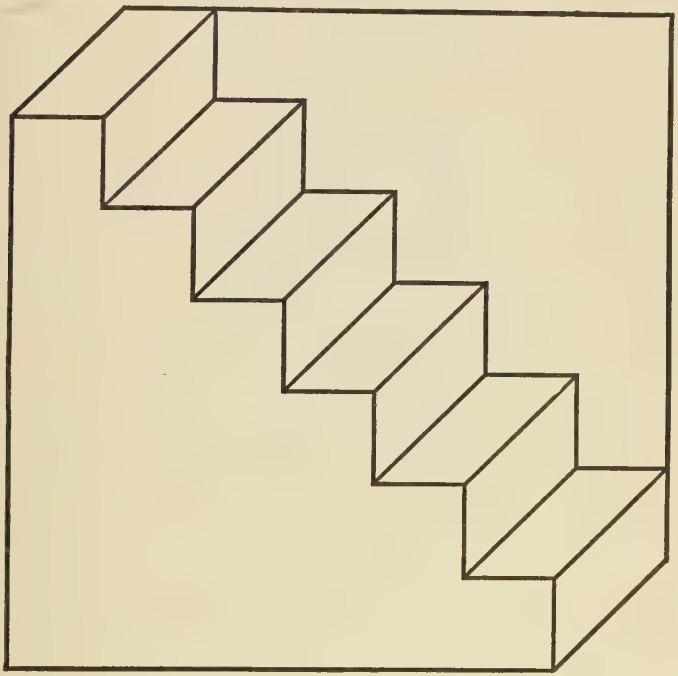

Fig. 25 — Ambiguous perspective of a stairway.

emplified by all landscape paintings. Some objects are perceived in the foreground and others in the distance, while as a matter of fact the canvas is a flat surface. Again we do not perceive the object as it is. The artist has created an illusion. The tri-dimensional organization of the sensuous data is obviously a product of the observer's reaction

to them, and this mode of reaction is an expression of the habits he has developed in dealing with a spatial world.

Past experience transforms the sensuous data by suppression and supplementation. In rapid reading, not all of the words or letters are sensed; a large portion of what we perceive in the printed page is supplied by a process of associative supplementation. In a very brief exposure of

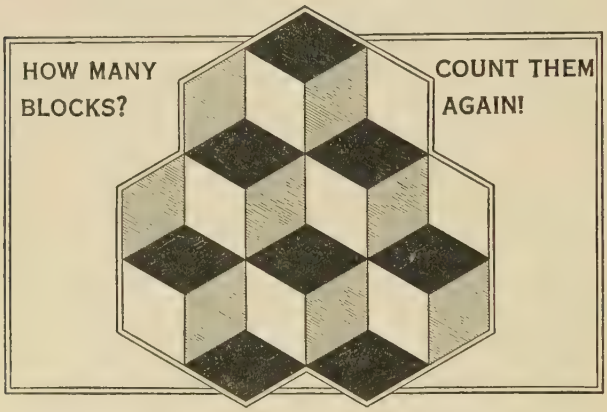

Fig. 26 — An ambiguous figure in which either six or seven cubes can be perceived.

printed material, the words may be properly perceived when incorrectly spelled or even when single letters are omitted. It is no uncommon occurrence for a subject to maintain that the omitted letter was just as distinctly and plainly perceived as those that were really present. Occasional errors of print will frequently escape the notice of an expert proof reader. In painting a marine scene, the artist may tinge the rocks on the shore with a vivid pink. The layman objects, and maintains that all rocks are gray. The artist replies that under the given conditions of light

these stones were suffused with this color and that he painted them in a realistic manner. The artist maintains that the layman has become so habituated to perceiving rocks as gray that he is no longer able to detect any occasional deviation from their customary appearance. In other words, the normal mind is accustomed to perceive objects, not as they are, but as they ought to be. For example, we almost invariably perceive a book as a rectangular object even though we may be viewing it obliquely. An untrained person experiences considerable difficulty in drawing objects in perspective because of his inveterate habit of perceiving all things in a *typical* fashion.

Attention. — Perception always involves an act of attention. Attention is a preliminary act of adjustment on the part of the organism that is conducive to a more effective apprehension of the object. Objects when attended to become clearer and more distinct. Attention to an object renders it a more effective stimulus for action. Attention serves to eliminate and suppress irrelevant and distractive stimuli. The attentive adjustment to an object is highly unstable and variable, emphasizing now one aspect of the complex object and now another. The eye wanders over a visual object, successively singling out its various details for effective vision. Every perceptual act is thus analytical in proportion to its duration. Attention often involves a process of synthesis. The search for a hidden animal in a puzzle picture is a good example. Attention serves to inhibit any immediate overt response until the object is adequately apprehended. For example, a stimulus in the peripheral field of vision releases nervous impulses which are at once utilized in innervating the muscles involved in effecting a more adequate ocular adjustment. Obviously this drafting of the initial impulses into the

ocular adjustment necessarily prevents any overt response until the object is more effectively apprehended.

The process of attentive adjustment may be relatively simple or quite complex. Its nature will vary with the sense organ affected, the character of the object, and the circumstances under which the object is perceived. The adjustments are relatively simple in perceiving sounds and odors. In listening to a faint sound, we turn our head to a favorable position, hold our breath, and keep motionless. In perceiving an odor, we sniff with our nostrils and then hold our breath for a moment. Attention to visual objects is a more complex adjustment. We turn our eyes, our head, and sometimes our whole body so that the stimulus will fall upon the fovea, — the most sensitive part of the retina. The two eyes converge upon the object in order to avoid the confusion incident to double images. The lenticular mechanism is adjusted to the distance of the object in order that it may be seen clearly and distinctly. The extent to which effective vision is dependent upon these ocular adjustments is readily apparent if one steadily fixates a pencil point held at arm's length, and notes the blurred appearance of the surrounding objects. Practically only one object can be seen clearly at a given moment of time.

Attention may involve other movements than those of the sense organ affected. As noted, we turn our head and body in the direction of the object fixated. Under certain conditions we may aid vision by shading our eyes with our hands. Likewise we may walk toward the object and stoop over in order to examine it more thoroughly. An attentive adjustment may thus involve a reaction of the entire organism. Such a complex adjustment can be distinguished from a consummatory response only in terms of function. Attention must be conceived so as to include all those

processes whose prime significance is that of promoting a more effective cognition of the object.

Meaning and Association. — Perception involves the apprehension of the meaning or significance of the object in relation to what we are doing or in relation to some contemplated mode of procedure. The meaning or significance of an object is dependent upon the indirect and partial arousal of some of the previous experiences associated with it. In a famous experiment conducted by Pawlow, a sound was frequently presented when a dog was responding to food. This sound finally became associated with, or integrated into, the food response, and this auditory stimulus became capable of indirectly arousing the food response. In other words, the dog finally reacted to the sound as though the food were present. A condition has thus been established in which the sound may mean food. The teacher awakens through the ear the child's vocal and ideational activities concerning a given object, and simultaneously presents a written or printed symbol to the eye. When this association is firmly established, the visual symbol has acquired a meaning in virtue of this association. In other words, the teacher requires the child to say cat and think of cat while looking at a given symbol, and when the two are firmly associated this printed symbol will be perceived as meaning cat. Learning to read may thus be defined as a process of establishing associations, or as a process of endowing symbols with meaning.

The dependence of meaning upon associated experiences may be illustrated by an enumeration of the various types of associations that are generally established in the course of experience and the great variety of meanings which a perceptual object acquires as a consequence.

The habitual character of a perceptual process is a

function of the integration of successive experiences. Habit increases the ease and readiness of the act, and gives it coherence and stability. The fact that a series of letters will, whenever possible, be perceived in certain groups or word units is due to habit. The so-called sense of familiarity, — the knowledge that we have perceived the object before, is based in part upon the habitual character of the perceptual process.

The successive visual impressions of an object are rarely the same. A house may be viewed from the front or the rear. The diverse experiences of any object are integrated together, and the meaning of any single aspect may depend upon those aspects which are invisible at the time. The visual impression of a closed book means something which contains print, and the sight of the outside of a house will suggest a knowledge of its interior appearance.

An object may be perceived through various sense avenues and these diverse experiences become associated, and as a consequence any sensuous aspect may suggest a knowledge of its other sensory qualities which are no longer present. A visible book means something which is hard, resistant to pressure, and possessing a certain degree of weight. Visible ice means something cold. Contact with fur or velvet will suggest their visual appearances. The taste and odor of food may be inferred from its looks. The appearance of a person may suggest his rasping voice. The sight of a musical instrument will suggest the nature of its tonal character, and conversely its visual characteristics may be inferred from its tone. In perception we may thus distinguish between sensory knowledge and that which is inferred or contributed by the factor of meaning. An appreciation of the color, size, and shape of a distant block of ice is mainly dependent upon the sensory factor, while a

knowledge of its coldness is a matter of inference or meaning.

Each object gets associated with all other objects of its class, and each particular object may thus be perceived, not as an individual, but as a member of a class. A tree may be perceived as an oak tree, as a tree in general, as a plant organism, or as a mere material object.

Objects are perceived in a given spatial and temporal environment, and many of these relations occur with a sufficient frequency to establish associative connections. The meaning of an object may thus be a function of its previous environmental circumstances. We may perceive a book as one that belongs to a friend. A person may be recognized as a chance acquaintance met on the battle fields of France. Another person is identified as a childhood friend. A lightning flash means potential thunder. Heavy clouds become the sign of impending rain, and a tree sighted in the distance may be recognized as one that is located on the bank of the lake near which we are camping.

Perceptual objects necessarily acquire certain associative connections with the observer, — with his actions, his appetites, his moods and emotions, and with the visual experiences of his body. A book is recognized as one that is interesting, dry, or profoundly distressing in its emotional effects. Reptiles are perceived as loathsome objects. Edible objects are recognized as things that will satisfy hunger. Umbrellas are cognized in terms of their use. Objects are characterized as pleasant or unpleasant and as desirable or undesirable things on the basis of the type of adaptive response that they normally elicited in times past (Chap. XIII). Objects also get associated with the sight of our own body. A pair of shoes is recognized as one which I

have worn. A house is perceived as one in which I formerly lived, and I recognize a resurrected toy as one with which I played during childhood. The existence and importance of these personal associations are often unnoted. They condition the 'personal reference' aspect of memory (p. 165), and are largely responsible for the associative unity of mental life (p. 346). Our reactions to objects are based to a considerable extent upon our knowledge of their personal significance.

The possibilities of establishing associations between objects are greatly enhanced with the development of thought, for a perceptual object may be directly associated with an object of thought. An effective association will be established between two objects when one is perceived and the other is ideationally represented. The contiguous existence of two objects in time and space is no longer an essential condition for their association. By means of ideas we can transcend the limitations of time and space. By means of ideas a perceptual object can be linked with future and past events and with objects that are located in any part of the universe.

All objects acquire a great many indirect connections in virtue of their direct associations. A given object A is directly associated with a series of objects B, C, D, etc., and each of these objects has been directly associated with another series of objects X, Y, and Z. Object A is thus indirectly associated with X, Y, and Z in virtue of its direct associative connection with B, C, and D. The significance of any object is a function of both its direct and indirect associations.

It is thus apparent that each perceptual object gradually acquires in the course of experience a multitude of associative connections, and thus attains a great variety of

potential meanings. Every item of experience becomes directly or indirectly connected with practically every other item of experience. If an adult person should attempt to analyze in a systematic and exhaustive manner all the meaning ramifications of a single perceptual object, it is not too much to assert that this account would embrace the major portion of his experience with the world (p. 346).

External objects do not intrinsically possess meaning. Rather they are endowed with meaning by the percipient organism, and the amount and character of the significance that they attain is a function of the individual's experience. The meaning of objects is thus a matter of growth and development. This fact is illustrated by the character of children's definitions, for a definition of an object is a statement of its meaning. Children tend to define objects in personal terms. A dog is an animal that barks, a knife is a thing with which to cut, and candy is something that is good to eat. These are all good and valid definitions in the light of the child's limited experience. Our conventional and dictionary definitions usually state the meaning of objects in more impersonal and universal terms. Children should not be expected to employ or understand such sophisticated statements. Neither can an adequate appreciation of such definitions be imparted by a few moments of instruction and explanation, for such an appreciation implies a rich background of interpretative experience and a considerable degree of mental development.

The Arousal of Meaning. — All objects thus acquire in the course of time a great variety of potential meanings, but relatively few of these are ever aroused in any given situation. The meaning that is aroused by any object is largely a function of the varying circumstances in which it is perceived.

1. The mode of perceiving an object is dependent upon the character of the objective environment in which it is perceived. The significance of a tiger in a cage is different from that suggested by the same animal in the open. Since the environment of most objects is highly variable, their meaning will vary from time to time.

2. A similar effect is exerted by the highly variable intraorganic sensitivity of the perceiving organism, — his motor attitudes, his postures, his moods and his appetites. The meaning of an apple will obviously vary with the hunger and satiety of the organism, and an optimist and a pessimist will evaluate the same world in different terms.

3. The meaning that is suggested by an object will vary with our purposes and what we are doing at the time. A person engaged in some constructive task requiring hammering will naturally perceive all surrounding objects in respect to their hardness and availability for pounding a nail.

4. The meaning of an object exhibiting any degree of sensory complexity will vary with the sensory aspect to which we attend. The significance of a picture is likely to vary as the eye wanders over it, successively singling out its various details for attentive examination. This attentive analysis of a complex situation serves the function of arousing a series of meanings until one is discovered that is relevant to our purposes.

In so far as the above principles are operative, it is obvious that we will apprehend objects for the most part in a manner that is appropriate and relevant to the situation in which they are perceived. Any perceptual system of habitual tendencies is highly complex. These tendencies preserve for the most part a highly plastic character, for

the mode of perceptual interpretation is highly variable, — being adaptable to the ever varying circumstances in which the object is perceived. Irrelevant meanings are sometimes suggested however. In this event, the object will be ignored, or it will exert a distractive effect upon what the subject is doing and elicit a response adapted to the new situation.

Although but one of the potential meanings that an object acquires is aroused in any given situation and we govern our reaction to the object primarily on the basis of this meaning, yet we must not assume that our response to the object is never affected by any of the associations that are not aroused in the form of meaning. Such associated items of experience frequently influence our conduct in a habitual and automatic manner. For example, a person desires to read something light and entertaining and scans his library and finally chooses his boyhood favorite, Huckleberry Finn. His reaction to the book has been primarily determined by his knowledge of its amusing character, and yet he has reacted to this visual impression as a *tangible* object. Likewise, we reach for a rose in order to enjoy its delicious odor, but we habitually handle it in such a way as to avoid its thorns.

Meaning is aroused only when we attentively examine and evaluate the object before reacting to it. Meaning arises only in so far as the situation involves a problem, — only in so far as the subject is in some doubt, however slight or temporary it may be, as to the nature of the object or as to the appropriate manner of reacting to it. It must be recognized, however, that no very serious difficulties are usually encountered in the course of our routine activities, and only a slight amount of perceptual guidance is necessary to effect these readjustments. In other words, most of our ordinary activities have become

so automatized that but little meaning is ever present during the process of perceiving. The great variety of meanings which we are accustomed to ascribe to objects are products of a later process of logical analysis. Meaning represents a reflective and analytical mode of utilizing the effects of past experience in effecting a readjustment, and the extent to which it is present is a function of the degree of difficulty that is encountered.

Nature of Meaning. — Some attributes of a perceptible object are sensed while others are inferred. In the perception of a block of ice at a distance, its color, size, and shape are sensed while its hardness and coldness are inferentially apprehended. Meaning refers to our inferential knowledge about an object as distinct from that which is obtained through sense. In perception we apprehend the sensory object and some inferred characteristic of that object in terms of their relation to some subsequent mode of reaction. Meaning is not an observable process, an independent item of experience. It has no separate existence apart from that which means and that which is meant. Meaning is an abstract and conceptual term whose use enables us to express the fact that every sensory object possesses a great variety of implications for conduct without specifying their individual character. An observable meaning process no more exists than does a 'dog in general.'

Meaning and Imagery. — Some psychologists assert that a previously associated experience can never function to give meaning to a perceptual object unless that experience is represented in the perceptual process in the form of an image. Visible ice at a distance can not mean a cold object unless one's previous experience of its coldness is revived in the form of an image. The sight of a person can

not suggest the character of his voice without the presence of an auditory image. The appearance of a dog can not be suggested by hearing its bark unless the animal is visualized. Likewise one can not visually perceive a lump of sugar as a sweet object without the presence of a gustatory image. This doctrine is usually known as the context theory of meaning. Some competent observers, however, assert that images are rarely if ever present in their perceptual experiences. On the basis of their observations, these individuals report that they can adequately apprehend the significance of objects without imagery. Other individuals, on the basis of their observations, adopt a middle ground between these two extremes. They assert that images are sometimes present when the meaning of an object is apprehended and that at other times they are able to appreciate what objects mean without the presence of imagery.

In view of these conflicting reports, we are forced to assume that individuals differ in respect to the presence of imagery in perception. In other words, an image is not an essential component of a perceptual act, for it is possible to apprehend the meaning of an object when no images are present. On the other hand, we must admit that images may be involved in the perceptual process, and this fact naturally suggests the hypothesis that these items of experience do subserve some function in the apprehension of meaning. Inasmuch as the question of the relation of imagery and meaning will again be encountered in the chapter devoted to thought, we shall now discuss at some length the nature of these alleged items of experience in order that the reader may make some decision concerning these mooted questions on the basis of his own observations.

The Nature of Images. — It is customary to describe images in terms of sensory experiences.

1. The orthodox doctrine asserts that images are qualitatively like sensations and are to be classified in a similar fashion as visual, auditory, kinæsthetic, gustatory, etc.

2. Images are less intense and vivid, more unstable and fluctuating in character, and more dependent upon the variable organic conditions of the subject than are sensory experiences.

3. Images are dependent upon previous sensory experiences. A person born blind will also lack visual imagery, while a person becoming blind in late life may retain his visual images thereafter. Images are thus derivative experiences. Images constitute one of the ways in which past experiences are revived and represented in the present.

4. Sensations are stimulated directly, while images are indirectly aroused through some associative channel. Any sensory mechanism, *i.e.*, a sense organ, nerve, conducting tract, and cortical centre, is directly stimulated when it is aroused to activity by the incidence of a material stimulus upon its sense organ or peripheral terminus. This mechanism is indirectly excited when its cortical terminus is affected by a neural impulse coming from any other sense organ via an association tract. For example, we simultaneously see and hear a friend talking, and the two sensory experiences become associated. We now chance to see this person at a distance. The optical stimulus directly affects the eye and arouses a visual sensation. Let us suppose that this neural impulse on reaching the visual centre in the occipital lobe is conveyed by an association tract to the auditory centre in the temporal lobe before finding its customary motor outlet in the Rolandic area (Fig. 12). The auditory mechanism is thus stimulated at its corti-

cal terminus in this indirect fashion and an auditory image is aroused in addition to the visual sensation.

Some psychologists assume that only the cortical centres of the various sensory mechanisms are involved in imagery. Sensations and images thus differ in their neural conditions. Sensations involve an activity of the entire sensory mechanism, while only the cortical centre is active in the case of images. Other writers assume that both sensation and images involve a reaction on the part of the corresponding sensory mechanism throughout its whole length. They assume that each sensory mechanism can be excited throughout its whole length by the application of an appropriate stimulus to either its peripheral or central terminus. A sensation is obtained when the auditory apparatus is stimulated through the ear, while an auditory image is aroused when this same apparatus is stimulated at its cortical end by an impulse received through some other sense avenue. Because of this assumption that the neural bases of images and sensations are identical, some writers call images centrally or indirectly aroused sensations as contrasted with those that are peripherally or directly excited. Such distinctions of terminology are not important, and the author will employ the more conventional term of image, although he subscribes to the latter conception concerning the neural basis of imagery. The neural conditions involved in imagery are largely a matter of speculation, however, and the advocates of neither view are justified in making any dogmatic statements concerning them.

Images are thus qualitatively like faint sensations. An auditory image is a sound, — something that is heard. Auditory images are present when we hear a tune running through our head as if it were very faintly played. Images of voices sound as if someone were whispering gently in our

ear. Visual images are genuine color experiences. To visualize a rose with closed eyes, its color or outline must appear visibly differentiated from the dark background. The visual experiences obtained in dreams are images. To image the taste of strawberries, one must obtain a faint experience of their gustatory qualities although the tongue is not directly stimulated. Images differ from sensations primarily in the fact that they involve no corresponding material stimulus.

From this account, the reader will surmise that images and sensory experiences are so much alike that confusion is likely to occur. As a matter of fact, laboratory conditions have been arranged in which competent observers very readily mistook one type of experience for the other. Confusions also occur in every day life. Persons frequently regard faint noises as imaginary and later discover their error. One hears a faint sound and thinks that someone is calling to him, but discovers his mistake upon investigation. Hallucinations represent wrong interpretations of imaginal experiences. There is a popular but erroneous belief that hallucinations occur only with insane or disordered minds. As a matter of fact, everybody is subject to hallucinations. With well balanced minds, these mistakes are usually inconsequential and attract no particular notice because the error is soon detected in the light of subsequent experience, for the existence of an hallucinatory object, unlike that of perception, can not be confirmed by an appeal to some other sense or to the experience of other persons. It is the persistent hallucinations, — those that are resistant to correction, that are the signs of a disordered mind. The most striking cases are those in which a subject persists in believing in the existence of a visible material object in spite of the fact that it is intangible and can not be seen

by others. Hallucinations are frequently interpreted as due to some spiritualistic agency. Joan of Arc is usually cited as the classical example. Many people are quite prone to believe that hallucinatory voices represent telepathic communications from absent friends.

Errors of Observation. — In observing the existence of images, the beginning student must guard against two very fertile sources of error. One must distinguish between thinking of an object and having an image of that object. The beginning student is prone to believe that he has an image of red because he can think of red, that he has an image of an apple whenever he thinks of that object, and that he has auditory images because he can think of sounds. If thinking of an object is equivalent to imaging that object, then every one possesses all kinds of imagery. In this case, the term image loses all its distinctive value for psychology, for everybody is able to think of colors, sounds, odors, and all other sensory aspects of objects. As we shall develop in a later chapter, imaging an object is but one of the various means by which a person can think of that object. The author can think of all varieties of sounds but has never been able to obtain an auditory image. Helen Keller has been blind and deaf from early childhood and presumably does not have auditory or visual images, and yet she has acquired a considerable degree of facility in thinking about sounds and colors.

A second type of error is the confusion between images and certain modes of sensitivity which are excited in the attempt to obtain them. The attempt to obtain a kinæsthetic image of an arm movement is likely to excite a slight contraction of the muscles in the arm, and this contracture will arouse a faint sensory experience which may be readily regarded as a kinæsthetic image. Many people report that

they are able to secure vocal imagery, while undoubtedly in many cases only sensations resulting from slight contractures of the vocal organs are present. The attempt to arouse a gustatory image of some attractive edible substance is likely to excite the flow of saliva and to initiate incipient movements of mastication and swallowing. An inexperienced observer will be prone to report these contact and kinæsthetic sensations as gustatory images because they are located in the mouth. The middle ear contains small muscles which perform an adjustive function in listening to sounds. These are almost certain to be excited to activity in intently listening for an expected noise. One can readily detect these sensations of strain by rapidly shifting the attentive attitude from one ear to the other. These sensory experiences in the ear must not be confused with auditory images. The same situation obtains for vision. The ocular muscles involved in accommodation and convergence are generally excited to some extent in every attempt to think of the visual aspect of objects, and a careless observer may report the existence of a visual image because of the presence of these ocular sensations.

Beginning students as a rule report a great variety of images, especially visual and auditory. Almost invariably these students, upon further study, conclude that images play a much less extensive rôle in their mental life. It does not follow that, because a person can obtain images under extremely favorable circumstances, they are therefore present in his every day perceptual activities. Students who fail to detect the presence of imagery must not decide that other persons do not experience them. Individuals differ in this respect. The fact of hallucinations indicates that images may occur, and occur much more frequently and vividly with some individuals than with others. Some persons re-

port the existence of color imagery with an objective location and strength similar to negative after-images. Errors of observation in such cases hardly seem possible. Competent observers have obtained a negative after-image from a previously induced color image. These observers arouse a visual image of a green square and maintain it for approximately a minute. This image is then followed by a red after-image which is similar in all respects to that obtained from looking at a green object. The author has occasionally obtained such after-images from students who knew nothing of the negative after-image relations of colors, and consequently the result can hardly be due to suggestion. Undoubtedly the possible existence of images must be admitted.

Function of Imagery. — The function of imagery in perception may be more readily comprehended with the aid of some neurological conception. The following device may prove useful to the beginning student. In our previous illustration, let us suppose that the person perceived has a voice so peculiar that it usually arouses an attitude of mirth and amusement in the auditor. Due to association, the visual presence of the person will tend to excite this type of reaction. He will thus be visually perceived as a man with a mirth provoking voice. If the visually initiated impulse is relayed through the auditory centre by means of the associative tract x before reaching its appropriate motor outlet M (Fig. 27), an auditory image will accompany

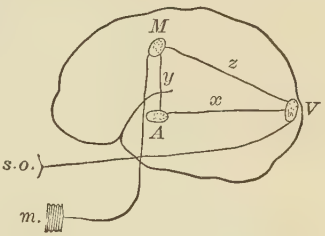

Fig. 27 — Schematic diagram, *s.o.*, sense organ; *m*, muscle; *V*, visual centre; *A*, auditory centre; *M*, motor centre; *X*, *Y*, *Z*, association tracts.

the visual percept and aid in the apprehension of its meaning. If the impulse is relayed directly from the visual to the motor centre by means of tract *z*, no auditory image will be present but the meaning will still be apprehended for we are reacting to his visual appearance as though we were listening to his voice. In general any sensory impression will mean a given object whenever it implicitly arouses a response which it has acquired in virtue of its previous association with that object.

Several facts can be readily conceived in terms of this hypothesis. It is obvious that images may occur in the perceptual activities of some individuals but not of others. An individual might become so organized as to experience only certain kinds of images. The kind of imagery present will vary with individuals. Imagery will tend to disappear as the perceptual activity becomes automatized and functions in a relatively stereotyped manner. Imagery will also tend to reappear when any implicitly apprehended meaning is subjected to a searching and thorough analysis.

According to this conception, the presence of imagery in perception will render the meaning more precise and definite and explicit in character. Without imagery, the meaning of a perceptual object will be apprehended in a more general and implicit manner. The presence of an image indicates a more complete and adequate and effective rearousal of the associated experience. Meanings that are mediated by imagery are more dynamic and effective stimuli to action (p. 321), and are more likely to arouse an appropriate and vigorous response.

Function of Perception. — Perception may serve three functions in the process of adjustment.

1. Objects are perceived as potential goals or objectives toward which to react. Objects are apprehended as things

to be attained, ignored, or avoided, and we then react to them on the basis of this perceptual appraisal.

2. Any initiated response may need perceptual guidance to insure the attainment of its objective. An unfolding act may thus be perceived from time to time in the attempt to comprehend its significance from the standpoint of attaining its objective. The act of reaching for a perceptual object may be inaccurately directed. This initial inaccuracy is perceived, not in order to adapt it, but in order to correct and modify it. Acts are thus perceived in terms of their relation to the goal, just as the goal is sometimes perceived as an object toward which to react.

3. Objects may also be perceived, not as an end or goal to be attained, but as a means of attaining some other objective. In attempting to escape from a burning building all objects will be perceived and reacted to as a means of furthering this end. Various aspects of a behavior situation may thus be successively perceived during the process of adjustment. What we perceive at any given time is a function of the exigencies of the situation. Perception is a process of cognitively evaluating any aspect of a behavior situation as a means of effecting an adequate adjustment.

As a rule we perceive objects in terms of their significance for further conduct. In other words, the process of perceiving is a constituent part of a larger act of adjustment, and it can be adequately comprehended only in terms of these wider relations. At times, however, our minds approximate a condition in which we perceive, not as a means to an end, but for the satisfactions involved in so doing. In other words, each perceptual process must be regarded as an independent act of adjustment that can not be explained in terms of any extraneous circumstances. As an example, we may cite the case where

we sit idly by with a passive attitude and casually observe whatever strikes our fancy. The situation is somewhat similar to that of daydreaming except that our minds are engrossed with objects of sense rather than those of imagination. A similar attitude of mind may be adopted in listening to music, or sensing odors, or observing the beauties of nature. We perceive these objects primarily for the sake of the sensuous enjoyment involved in so doing.

Perceiving vs. Sensing Objects. — In our previous analysis of an adaptive reaction, we described the complexity of the sensory situation, and called attention to the fact that all elements of this situation necessarily exert some influence upon the character of the response. Only one aspect of this complex situation is perceived at any given moment. Nevertheless, all other aspects of that situation are apprehended in a vague fashion, and we shall term this apprehension a process of *sensing*. Sensing an object differs from perceiving in that the process involves no attentive adjustment toward the object, or any appreciation of its significance before reacting to it. Sensing involves a vague apprehension of the existence of a stimulating situation and an immediate reaction to it. Our intraorganic activities are usually sensed and not perceived. A person perceives the action of his heart only when it presents such unusual features that it is attentively examined and appraised from the standpoint of further conduct. On the basis of such a perceptual examination, we may decide to ignore the condition, indulge in less strenuous exercise, or consult a physician. We usually sense the movements of our legs and the contact of our feet while walking, and these sensations are essential components of the act. Situations may arise, however, in which this act will require a certain amount of perceptual guidance.

EXERCISES

1. Enumerate and illustrate the various ways in which past experience may be reflected in a perceptual act.

2. In what respects does perception fulfill the definition of a mental act as given in Chapter I?

3. Compare the treatment of attention as given in Chapters IV and VI. Can you perceive an object without attending to it? Can you attend to a sensory object without perceiving it?

4. Can you perceive the object and your adaptive response to it simultaneously?

5. Can you perceive an object without apprehending its significance? Its significance for what? Do you ever perceive objects because of the immediate satisfaction in so doing rather than as a means to some further end?

6. Does the printed page contain any meaning, or is the meaning a product of your perceptual reaction to these visual symbols?

7. Do objects inherently possess meaning, or do they acquire it in the process of mental development? Why do objects acquire similar meanings for all individuals? See Exercise 12, Chapter V.

8. Try to obtain the various kinds of images, and compare your results with those of the other members of the class.

9. What difficulties did you encounter in making your decisions as to the presence of images?

10. If you obtain visual images, compare them with negative after-images. See Exercise 5, Chapter III.

11. To what extent are images present in your perceptual experiences during your ordinary activities? Do you ever appreciate the significance of objects without imagery?

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CHAPTER VII

PERCEPTION OF SPACE

The term space perception refers to the apprehension of the size, shape, position, and movements of objects. Of these, the perception of the locality of objects is the most important as practically all adaptive responses toward external objects imply some sort of an appreciation of their position in reference to each other and to the percipient subject. Locality, unlike size and shape, can be perceived through any sense avenue, but our discussion will be confined to the most important of these, *viz.*, contact, vision, and hearing.

Spatial Coördination of the Senses. — Our senses agree fairly well in the perception of space. A bell is seen where its sound is heard, and a person sees and feels his hand in the same place. Although our senses have coöperated in this effective fashion as far back as we can remember, we are not justified in assuming that this ability was present at birth. Several lines of evidence indicate that this ability was to a large extent acquired and that these habits of cooperation were established in early childhood. The behavior of infants in their attempts to respond to the location of objects indicates the lack of any very accurate localizing ability. Evidence has been obtained from subjects blind from birth who later attained vision as a result of an operation. While the evidence is not conclusive in all respects, these subjects undoubtedly exhibit very little

ability to interpret their visual experiences in terms of touch and hearing. Some significant results have also been obtained by experimental means. Visual objects are deflected in position when observed through a prism. A bell will be seen in one place and heard in another. Any attempt to touch the visual object will go astray, but this ability to respond successfully to the appearance of objects may be readily reattained with a little practice.

A systematic experiment of this sort was conducted by Stratton. With one eye bandaged, he placed before the other eye a system of lenses which altered the apparent location of visible objects in a very striking manner. This optical device was worn continuously during his waking hours for a period of eight days. Vision no longer cooperated successfully with the other senses. A sounding object was seen in one place and heard in another. In grasping an object, the hand and the object were seen in one position, but they were tactually perceived in a different location. Conceptual space no longer conformed with sight. Objects were not visually perceived in harmony with the subject's expectations when thinking of them. The subject was able to respond successfully to the auditory and tactual aspects of objects when vision was excluded or disregarded. Adaptive responses were invariably incorrect when guided by vision, and a process of trial and error exploration was necessary to discover the location of the object. Inasmuch as the subject attempted to carry on his daily routine of activity without assistance, this motor defect was a source of much confusion and amusement. Objects were encountered in the very attempt to avoid them. In dressing, each article of clothing was located only after a patient search. At the table, the hand might grasp the butter in reaching for the fork, and the attempt to sit down

in a chair was likely to prove embarrassing. This motor disability gradually disappeared during the experiment, and the subject was finally able to respond correctly to visual objects in a perfectly normal manner. The subject thus acquired a new system of visual-motor habits that were adapted to the novel optical conditions. Coincident with this motor recovery, the illusory location of visual objects disappeared. An object was now seen in the place where it was heard and felt to be. Conceptual space was also reorganized in a manner adapted to the new conditions, and the whole world once more seemed perfectly natural and normal. The same difficulties were again encountered with the removal of the glasses, but the confusion was not so pronounced and recovery was attained in a shorter time. The experiment proves that the spatial agreement of the senses is a matter of their functional coordination. Since the normal coördination, representing a lifetime of experience, may be disrupted and a new mode of successful coöperation be readily acquired, it is evident that the perfection of the normal coördination during early childhood is easily within the bounds of possibility.

The following conception may be found useful in understanding these data. A person perfects, in the manner described in Chapter V, a series of localizing movements, each of which is adapted to some particular visual stimulus. In like manner, corresponding series of localizing movements are acquired for the various auditory and tactual stimuli. Each adaptive response consists of an association between a stimulus and a localizing reaction, and these motor responses are adapted to the stimulus when they succeed in manipulating and modifying it in ways that satisfy the motivating conditions (p. 72). A visual stimulus is correctly localized when the subject is able to grasp

or avoid it. A reaction to the sting of a mosquito which succeeds in removing the irritation is evidence of the fact that the pain has been adequately localized.

Stimuli from diverse senses may elicit the same reaction. A given sound may initiate the same response as does a visual stimulus. When both stimuli are presented, it is a matter of indifference whether the subject reacts to sound or vision, for the resultant response is adapted to both stimuli. The act of grasping a ringing bell will affect both its sound and its visual appearance. In this case, the two diverse sensory experiences are regarded as belonging to a common object and having an identical location. In other words, the sound will be localized within the field of vision. When an auditory stimulus initiates a localizing response different from any of those belonging to touch and vision, this sound will be referred to some position extraneous to visual and tactual space. A tactual stimulus, which excites the same localizing reaction as does a visual stimulus, will be regarded as having the same location. In this way a person learns to identify certain parts of his body as tactually perceived with their appropriate visual equivalents, while all those tactual experiences that are localized by movements different from those that are elicited by any visual stimulus will necessarily be referred to some position in non-visual space.

Stratton's results may be readily comprehended in terms of this conception. The subject has perfected a system of retinal-motor habits that are adapted to the locality of visual objects. These habits consist of associations between retinal stimuli and appropriate localizing movements which are schematically represented in Figure 28 by a-x and b-y. The object located at B stimulates the retinal point b and arouses a localizing movement that is adapted to its

position in space. The object located at *VA* likewise affects the retinal point *a* and arouses the movement *x* which is adapted to its position. The object *VA* is also a vibrating body, and we shall assume that this auditory stimulus likewise arouses the localizing response *x*. Since the two stimuli elicit the same response, both the visual and auditory experiences, *V* and *A* respectively, are localized in the same place and are regarded as two sensory aspects of the same object. Let us assume that a prism is now placed before the eye that will so deflect the light waves that the two objects will stimulate the retinal points *b* and *c* respectively. Since the subject will react to the visual stimuli on the basis of his established system of retinal-motor habits, the object located at *VA* will elicit the localizing response *y* that is adapted to the position *B*. The visual aspect of the object *VA* will thus be localized at *B*, while the apparent position of this latter object will also be shifted to the right. Inasmuch as the prism will in no way affect the auditory stimulus, the object *VA* will be correctly localized by means of the ear. In other words, this object will be seen in one place and heard in another. The subject is now compelled to acquire a new system of associations between retinal points and localizing

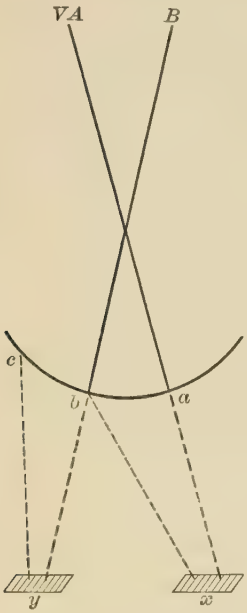

Fig. 28 — Schematic diagram. *VA* and *B*, stimulating objects; *a*, *b*, and *c*, retinal points affected; *ax* and *by*, retinal-motor associations; *bx* and *cy*, new system of retinal-motor associations.

responses that is adapted to the novel optical conditions. By a trial and error process, an association will in time be established between *b* and *x* and between *c* and *y*. When this new system of retinal-motor habits is thoroughly established, the object *VA* will again elicit the response *x* by way of either the eye or ear, and the object will be seen and heard in its normal position. When the prism is removed, the subject will naturally attempt to respond to visual stimuli on the basis of his new system of retinal-motor habits. The object *B* will awaken the response *x* and hence be seen at the position *VA*, while the apparent location of this latter object will be shifted to the left. Again, the object *VA* will be seen in one place and heard in another, and the subject is now compelled to relearn his old system of associations, *a–x* and *b–y*, and vision and hearing are properly coördinated once more.

The subject thus comes to the experiment with an established system of retinal-motor habits that are adapted to the normal conditions of vision. With the introduction of the novel optical conditions, this old system of localizing responses fails to work, and the subject is compelled to develop a new system of retinal-motor habits that are adapted to the new conditions. With the removal of the lenses, the subject attempts to utilize the new system of habits and failure and confusion naturally result. As a consequence, the subject is compelled to relearn his old system of habits and normal vision is once more secured. It is thus obvious that the Stratton experiment involves no reconstruction or alteration of tactual and auditory space. It is the visual system that is disrupted and then reorganized so as to conform to touch and hearing.

In general, two perceptual experiences from diverse sensory avenues attain a common location and become welded

into a unitary object through the medium of their association with a common localizing movement, and these associations in the main are gradually perfected in early life. In this way, a person learns to identify the various experiences obtained through one sense with their proper equivalents in other sense realms. Visual, tactual, and auditory experiences are not originally interrelated in any definite and precise manner. They become related to each other in an orderly fashion only as the subject perfects an adequate system of localizing responses for the various stimuli that affect each sense.

Local Signs. — The spatial coördination of the senses is thus an incidental result of the development of adaptive responses to objects that are perceived through diverse senses. Psychology thus needs to explain only how individuals are able to adapt successfully to the position of an object as its location is changed. As a sounding object is moved about in space, the perceiving subject can alter his localizing reaction accordingly. In order to explain this fact, it is necessary to assume that these variations of response are based upon and conditioned by correlative differences in the auditory stimulus. In other words, the auditory stimulus, *i.e.*, the effect which the vibrating object exerts upon the ear, must vary in a characteristic manner as the position of the object is altered. These differential aspects of the stimulus that correspond to the various locations of the object we shall term *local signs*. The ability to adapt successfully to the varying position of an object thus depends upon the development of a system of associations between each local sign and an appropriate localizing response. We thus need to enumerate the various local signs that are utilized for each sense.

In the process of mental development, a person first as-

sociates an overt localizing response with each local sign. As these associations become firmly established with use, the location of an object, in conformity with the principles developed in the previous chapter, can be appreciated as a meaning without the necessity of responding in an overt manner. The subject expresses these spatial meanings of objects in terms of verbal judgments, but these judgments of locality, like the overt localizing responses from which they are genetically derived, are also based upon this system of local signs.

If one's judgments of locality are to be adapted to objective conditions, a person must utilize as local signs those aspects of the stimulus which actually do vary with the position of the object. The nature of these signs may thus be inferred from our knowledge of the physical principles involved, and their efficacy can then be tested by experimental means.

Auditory Localization. — Intensity and tonal complexity are the local signs of the *distance* of sounds. Sounds are judged to be near in proportion to their apparent loudness and tonal complexity. Obviously these factors do vary with distance. The more removed the source of a sound wave, the less effectively will it stimulate the ear. Vibrating bodies emit a series of overtones of varying strength. When the object is close at hand, all the overtones stimulate the ear and a complex sound is heard. With greater distances, only the stronger partials are heard, and finally only the fundamental tone is audible. This fact accounts for the apparent change in the nature of a sound with the distance of the object. A locomotive whistle in the far distance is hollow, flat, and sonorous because of the absence of overtones. When near at hand, the sound is shrill, harsh, rough, and piercing on account of the presence

of high and dissonant partials. The ventriloquist utilizes these principles in creating his distance illusions. The effectiveness of the two criteria may also be easily demonstrated by experimental means. For example, two tuning forks of the same pitch are placed at an equal distance in front of a blindfolded subject. When these are sounded in succession with a noticeable difference in intensity, the louder of the two will be judged to be the nearer.

The student must not confuse the physical and the psychological principles involved. A person hears a sound as loud because of its nearness, but recognizes its near location because of its loudness. The first statement expresses a law of physics, and the second a principle of psychology. One must not naïvely assume that these criteria of distance are utilized as a result of the subject's knowledge of the physical principles involved. As a matter of fact, most people are ignorant of their methods of estimating the distance of sounds, and these methods were developed in early childhood long before the attainment of any knowledge concerning the physics of sound.

The appreciation of the *direction* of sounds is based upon the *binaural ratio* of stimulation. When the two ears are stimulated by a vibrating body the two auditory experiences are normally fused into a single sound. When the object is located in the median plane of the head and hence at an equal distance from the two ears, naturally the two stimuli will be alike in intensity, tonal complexity, and phase. The term ' similarity of phase ' means that the two ears are affected coincidently by the condensation or rarefaction phases of the air wave. The ears are stimulated in the opposite phase when the period of rarefaction in one ear coincides with the period of condensation in the other. When the object is located to the right of the subject, the

stimulus for the right ear will be the more intense and complex, and for certain locations the ears will be stimulated in opposite phases.

The utilization of this physical principle in judging the direction of sounds has been amply demonstrated by experimental means. The psychological principle involved may be stated as follows: — Whenever the two ears are equally affected, the sound is judged to be located somewhere within the median plane of the head. When the right ear is the more effectively stimulated, the sound is localized to the right of the median plane, while all sounds will be localized to the left of the median plane when the left ear receives the stronger stimulus. For example, blindfolded subjects with the left ear plugged consistently locate sounds to the right of their actual position. Persons afflicted with a partial deafness in one ear are subject to errors of localization. If the left ear is deaf, they locate sounds to the right of their actual position, while errors in the opposite direction are made when the right ear is defective. The difficulty may be corrected in time by learning to associate each position in space with a new binaural ratio of stimulation. Whereas a person normally locates the sound in the median plane when the two ears are equally stimulated, he may learn, after becoming slightly deaf in the left ear, to associate equal stimulation with a position to the left.

When two similar sounding bodies are placed in a symmetrical position in respect to the median plane of the head and are sounded simultaneously, only one sound will be heard. If the two objective stimuli are equal in intensity, the resultant sound will be located in the median plane and not at the position of either of the vibrating objects. If the left object be sounded the more intensely, the

sound will be located to the left of the median plane. If one holds two telephone receivers to the ears and the current be broken, the resultant click is frequently heard inside the head, — being located in the back and upper part of the throat. If one of the receivers be now removed a short distance from the ear, the resultant sound will be localized in the plane of the opposite ear, *i.e.*, in the region of the ear that is the more effectively stimulated.

Certain monaural criteria can be utilized in judging the direction of sounds. Subjects have been tested who have been pronounced by competent aurists to be totally deaf in one ear. Some ability to judge the direction of sounds was manifested, and this ability improved with experience. The binaural factor has evidently been excluded in these cases. The results indicate that the monaural criteria are used but little in normal experience, and that a person can learn to rely upon them when the binaural factor is excluded. The tests indicated that the apparent intensity and tonal complexity of sounds were the factors involved in these judgments. With monaural deafness, it is apparent that a sound located on the side of the good ear will be a more effective stimulus than when placed in a corresponding position on the opposite side of the head.

Auditory localization at best is quite defective. By the use of the binaural factor, one can determine quite accurately whether the source of the sound is in the median plane or situated to the right or left, but an appreciation of positions within the median plane or the right and left hemispheres is extremely inaccurate. In normal experience, the deficiency of auditory localization is supplemented by other means.

1. Head and body movements are employed for this purpose. When a sound is located to the right but a more

accurate definition of its direction is demanded, one can turn the head until the sound is heard in the median plane.

2. Vision and memory are also effective aids. The nature of the object is first identified from the character of the sound, and the object is then localized in terms of vision or by means of memory. One hears a voice of whose position he is uncertain. On the basis of its tonal character, the voice is recognized as that of a friend, and this person is then located with the aid of vision.

Visual Localization. — The visual experiences of the body become identified with and located in reference to their somæsthetic equivalents in the manner already described. Extraneous visual objects are then localized in reference to the body as visually or somæsthetically perceived by means of certain local signs.

There are various local signs of *distance*, the most important of which are aërial perspective, geometrical perspective, superposition, distribution of light and shade, accommodatory and convergent strains, and binocular parallax. Aërial perspective includes a number of factors. An object at a distance presents a blurred outline, many of its details are invisible, its resultant stimulus is less intense, its color is less saturated as a consequence of the decrease of intensity and the smaller size of its retinal image, and its color tone is altered in hue because of the intervening atmospheric haze. Geometrical perspective includes the position of the object in reference to the horizon, and the size of the retinal image. The apparent size of the object is effective in determining distance only when its real size can be inferred from the character of the stimulus or by a comparison with other objects in the environment whose normal size is known. An object which partially intercepts the

vision of another object is interpreted as being the nearer. An object may be perceived through the shadow cast by another object located in front of it. The more distant parts of a solid object stand in the shadow of those parts that are located nearer to the observer. In reality the criterion of light and shade can be included under the principle of superposition.

Several of the above factors are utilized by the artist in producing his illusions of depth in pictures, and this fact may be considered as a proof of their efficacy. To make a tree appear in the background, the artist locates it nearer the skyline, draws it proportionally smaller in size, uses less saturated colors, renders its outline somewhat vague and indistinct, and does not represent all its details of leaf and branch. Parts which are hidden from view by intervening objects are not represented.

The efficacy of many of these factors is illustrated by the distance distortions which may be obtained by viewing objects under certain unusual conditions. Viewing objects from an elevated position or with the head close to the ground modifies their respective positions in respect to the horizon and alters their apparent distance from the observer. In the clear atmosphere of mountainous regions, objects appear much nearer than they do in places where the atmosphere contains a considerable amount of haze. Objects encountered in a dense fog exhibit unnatural size and distance effects. Weird distance effects can be obtained by viewing distant objects from a vessel at sea. The uncertainty of such judgments is probably due in the main to the absence of any intervening objects which can be utilized for comparative purposes.

The influence of size and intensity may be readily demonstrated by experimental means. Two weak lights are

placed at the same distance from the observer in a dark room. When the lights are alike except in size, the larger one will be perceived as the nearer. When they are alike except for intensity, the weaker of the two will be seen in the more distant position. The illusion is very striking and it can be readily obtained when the observer knows that the two lights are equally distant.

For clear perception of an object, the curvature of the lens must be adapted to the distance of the object. These variations of curvature are effected by changes of contracture on the part of the ciliary muscles located within the eyeball. Each eye obtains an image of an object, and in order that the two images may have an identical location and the object be seen as single, the two eyes must be converged upon the object. The degree of convergence necessary to obtain unitary vision will vary with the distance of the object. The two motor activities of accommodation and convergence are closely associated, and in both cases muscular contraction is involved in the adjustment for near locations and a condition of relaxation is necessary for distant positions. It is thus possible for the kinæsthetic and cutaneous sensitivity resulting from these adjustments to be utilized as local signs of distance.

Several lines of evidence indicate the effectiveness of these factors in the perception of distance. In other words, visual objects are judged to be near in proportion to the ocular strain involved in perceiving them. For example, the distance of a faint light perceived in a dark room may be estimated with some degree of accuracy, and presumably all other clues to distance are excluded by these conditions of observation. A similar bit of evidence is the ability to appreciate to some extent the distance of negative afterimages perceived in a dark room or with closed eyes. The

validity of the principle has also been established by experiments of a more technical character.

Convergence and accommodation normally work together, but they may be dissociated or varied independently to some extent. By this means, experimenters have attempted to determine the relative importance of the two as signs of distance. The independent alteration of convergence in certain stereoscopic experiments modifies the apparent distance of objects to some extent. The tests for accommodation have not been so successful, for these alterations are generally accompanied by changes of other distance clues such as the intensity and size of the stimulus. It is generally supposed, however, that both accommodation and convergence are effective.

The term binocular parallax refers to the fact that the two eyes observe any object or group of objects from a different angle. From the principles of geometrical projection, it is evident that the two retinal images of a flat surface like a picture must be identical, while the two images of a solid object will necessarily be somewhat different. The latter fact may be attested by looking with the two eyes alternately at the edge of a book held a short distance in front of the head. Likewise, the two retinal images of a group of objects located at equal distances from the observer will be alike, but the spatial arrangement of these objects in the two retinal images will differ if they are situated at different distances from the subject.

The effectiveness of the binocular disparity of retinal images in mediating an appreciation of depth has been thoroughly established. The general principles involved may be stated as follows: — A similar spatial arrangement of the elements of the two retinal images of an object or group of objects is conducive to the perception of a flat surface.

With a dissimilar horizontal arrangement of these elements, depth or differences in distance will be perceived, and the greater the dissimilarity, the more pronounced will be the depth effect.

The binocular parallax is entirely responsible for the superiority of binocular vision in judgments of the relative distance of objects. This superiority may be readily demonstrated. If one holds a pencil at a distance of several feet from the eyes, and then attempts to place the forefinger of the other hand directly over the pencil point, he will find that a greater number of these attempts will be successful with binocular vision than when one eye is closed.

The validity of these principles may be demonstrated with the use of a stereoscope. In taking stereoscopic pictures, two cameras are employed. These are placed side by side at a distance apart equalling that separating the two eyes. Two photographs of a landscape scene are taken simultaneously. Obviously the two photographs are spatially dissimilar, but they correspond to the two retinal images that would be obtained by binocular perception. The photograph from the right camera is placed on the right side of the stereoscopic slide, and the left picture on the left side. When this slide is placed in the stereoscope, the small wooden screen in front of the lenses permits each eye to see only its corresponding picture. The deflecting lenses of the instrument cause the eyes to be so stimulated that the two visual images are seen in the same place although the two eyes are adjusted to the distance of the stereoscopic slide. Since the stereoscope presents two dissimilar images to the eyes, a normal depth effect is secured similar in all respects to that which obtains when the scene is actually observed. The stereoscope thus duplicates with the use of photographs the normal conditions of binocular vision.

If, however, two copies of the same photograph be mounted upon the stereoscopic slide, two similar retinal images will be obtained, and no depth will be perceived in the picture. By placing the cameras farther apart than the intraocular distance and thus increasing the degree of binocular parallax, a greater degree of dissimilarity between the two retinal images will be obtained, and the depth effect will be exaggerated. The very pronounced depth effects exhibited by commercial stereograms are obtained in this manner. The depth effect may be reversed by the simple procedure of interchanging the positions of the two dissimilar photographs on the stereoscopic slide. With stereoscopic pictures of the moon, its surface will appear as convex when the slide is prepared in the usual manner. Its surface will be perceived as flat if two copies of the same photograph are used. When the two dissimilar pictures are used with their positions interchanged, the moon will be perceived with a concave surface. The dissimilar arrangement of the objects may be readily noted in the stereogram represented in Figure 29. It is quite apparent that the man's head is differently located in the two pictures in respect to the objects in the background.

An optical device which in effect interchanges the two retinal images while a person is binocularly observing actual objects is known as a lenticular pseudoscope. If the proper conditions are secured, the distance relations of two objects may be reversed, the more distant object appearing the nearer. If the two observed objects are so placed that the nearer object does not intercept the vision of the more distant one, their reversal in position is readily obtained. If the experimenter moves one of the objects in a lateral direction so that the near object partially intercepts the vision of the other while they are being pseudo-

scopically observed, the reversed distance effect will be immediately destroyed. The binocular criterion of distance is thus brought into opposition with the suggestive influence of *superposition,* and the latter factor prevails. Likewise if an object with a concave surface be pseudoscopically observed, it will be perceived with a convex surface provided that the lighting conditions are so arranged that the

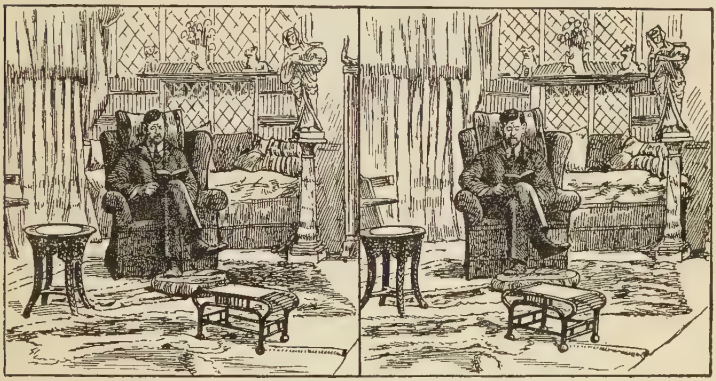

Fig. 29 — Stereogram illustrating the different spatial arrangement of the objects in the two photographs.

suggestive effects of shadows are eliminated. These two tests demonstrate the effectiveness of superposition and shading as signs of distance.

The perspective effect of a painting can be better appreciated with monocular vision than when both eyes are used. This fact supports the assumption of the influence of the binocular criterion. Since a painting presents a flat surface to the eye, the two retinal images are necessarily similar, and this similarity operates to give the subject the impression of a plane surface when the object is perceived with both eyes. The binocular factor thus opposes the influence of the various monocular signs of distance which

the artist has utilized to suggest depth, and it succeeds in diminishing their effectiveness to some extent.

With the stereoscope, the binocular factor accounts for the distance relations of the various objects within the picture, but the apparent distance of the scene as a whole from the observer is dependent in the main upon accommodation and convergence. Apparently for this reason the doctrine is sometimes advanced that in normal perception the binocular factor accounts only for the appreciation of the distance relations of external objects in reference to each other, but not for their distance from the observer. The erroneous character of this conception is evident on a moment's reflection. The dissimilarity of retinal images aids in the appreciation of the depth relations of *all visual objects* in relation to each other, and obviously the observer's body is usually visible in normal perception.

The connection between the majority of these signs of visual distance and the localizing reactions has for the most part been acquired in early life. So far as can be determined from the reports of those who attain vision late in life as the result of an operation, their visual world as initially perceived does not exhibit those pronounced and clear-cut distinctions of depth relations which obtain for adult vision. Evidently the initial character of the visual world of space is extensively transformed by experience. Moreover, these signs of distance are utilized in an automatic and unreflective manner, and most people are totally ignorant as to the sensory basis of their distance judgments.

The *directional* location of visual objects depends upon 1, their sensory relation to the body as visually perceived, 2, the position of the eyeball in the socket, and 3, the part of the retina affected. Those aspects of the visual world that represent one's own body become localized in relation

to the somæsthetic perceptions of the body as previously described. The directional location of any external visual object to the visual percept of the body is thus defined in part on the basis of visual sensory data. The influence of this factor is indicated by the fact that the appreciation of the direction of a negative after-image is more uncertain and indefinite in nature when the image is perceived in a dark room or with eyes closed than when the body is also visible.

The influence of bulbular position is proven by the fact that the apparent direction of a negative after-image with eyes closed is altered by rotations of the eyeball. These rotations are presumably effective in two ways. They alter the visual relation of the object in question to the body. So far as this avenue of connection is concerned, the influence of eye position constitutes a special case of the first principle enumerated. Judgments of the direction of a visual object are also based upon the kinæsthetic and cutaneous sensitivity involved in rotating the eyes and assuming any given ocular attitude.

The differences of direction of visual objects are conditioned by correlative differences in the retinal position of their stimuli. The doctrine of local signs as originally formulated assumed that differences of localizing reaction can be based only upon some observable aspect of the sensory experience. As a contact object is moved over the surface of the skin, the ability to vary the localizing response in an appropriate manner was assumed to be conditioned upon some observable concomitant change in the sensation of contact. The same assumption was made for vision. The sensory character of a visual object was supposed to vary in a characteristic manner as its position within the visual field was shifted. Since these alleged

conscious signs of the position of an object on the skin or within the visual field can not be detected by observation, certain genetic theories of space were evolved to account for their disappearance. Such assumptions are wholly unnecessary. Discriminative spatial reactions can be based upon any difference of stimulating conditions, — differences of parts affected as well as by differences in the material stimuli or the character of the resultant sensory experiences. A series of similar neural impulses conducted over different sensory tracts can readily become associated with and elicit a corresponding series of distinctive localizing responses.

Visual Perception of Size. — The apparent size of a visual object depends upon (1) the size of the retinal image, (2) the position of the stimulus on the retina, (3) the apparent distance of the object, and (4) the character of its immediate environment. The influence of the first principle is obvious. All other factors being equal, the apparent magnitudes of two visual objects are proportional to the relative size of their retinal images.

Fig. 30 — Vertical-horizontal illusion. The vertical line appears longer than the horizontal line of the same length.

The second principle is illustrated by the vertical-horizontal illusion. In Figure 30 the vertical line appears longer than the horizontal line although the two are equal in length. In Figure 31 the vertical dimension is equal to the horizontal one although the former appears to be the greater. To

make the sides of a square appear equal in length, it is thus necessary to draw the vertical lines somewhat shorter than the horizontal ones. The size of an object in the peripheral field of vision is differently estimated than when it is directly fixated. This influence of position may be due to anatomical peculiarities of the eyeball or to differences in sensitivity of the various portions of the retina. Other types of explanation have also been suggested. Authorities do not agree in the matter.

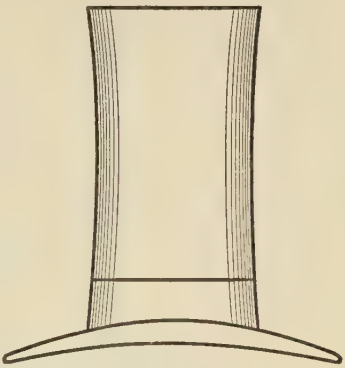

Fig. 31 — Diagram illustrating the vertical-horizontal illusion. The vertical and horizontal dimensions of the object are the same. (From Luckiesch's Visual Illusions and their Applications.)

The apparent size of an object increases directly with its apparent distance when all other factors remain constant. This principle is nicely illustrated by a negative after-image experiment. If one

Fig. 32 — The feet present a normal appearance when the pictures are stereoscopically perceived.

develops a negative after-image of an object located on a wall some five feet distant and projects this image on a surface close at hand, it will appear much smaller than the object from which it was obtained. Likewise it will appear much larger when projected against a more distant surface. In the stereoscopic photographs of a man in a reclining position with his feet directed toward the cameras, his feet appear in enormous proportions in comparison with his head (Fig. 32). When this stereogram is stereoscopically observed, the distorted size effect is not present. With direct observation of the pictures, the feet are seen near the plane of the head. With stereoscopic vision, they are perceived at their normal distance in front of the head, and as a consequence they appear reduced in size in proportion to their near location.

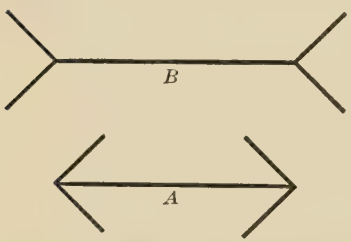

Fig. 33 — The Muller-Lyer Illusion. Line *A* appears shorter than *B*, although the two are equal in length.

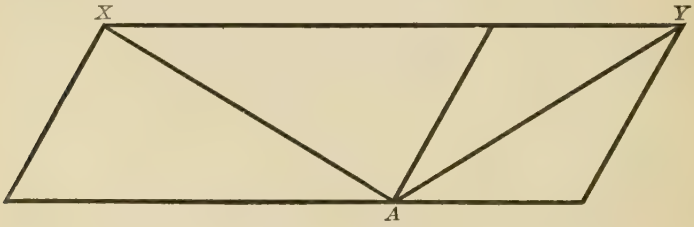

Fig. 34 — Line *AX* appears longer than *AY*, although the two are equal in length.

Illustrative examples of the fourth principle are given in Figures 33 and 34. In Figure 33, the straight line *A* appears much shorter than line *B* although as a matter of

fact the two are equal in length. In Figure 34, the diagonals AX and AY are equal in length although AX appears to be the longer. These distortions of linear magnitude are due to the suggestive influences of the adjacent portions of the diagrams. Numerous theories have been proposed to account for these effects, but the validity of none of these has as yet been thoroughly established.

Visual Perception of Form. — The principles underlying the perception of form are practically identical with those involved in the estimations of size.

1. The influence of the shape of the retinal image needs no comment.

2. The apparent shape of objects is slightly influenced by the retinal position of the stimulus. Straight lines tend to appear slightly curved when peripherally observed.

3. The form of an object is determined by the perspective or depth arrangement of its various parts. This fact is illustrated by the ambiguous perspective of Figures 25 and 26. The apparent shape of a negative after-image can be modified in startling ways when projected against various oblique surfaces. The same principle is illustrated by the fact that a table top is invariably perceived as rectangular although a rectangular retinal image of this object is very rarely obtained in ordinary experience. Likewise in Figure 35, all oblique angles are perceived as right angles, while all right angles appear oblique.

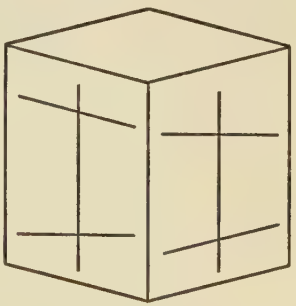

Fig. 35 — The oblique angles are perceived as right angles, and the right angles are perceived as oblique, because of the influence of perspective.

4. The influence of adjacent objects is illustrated in Figures 36 and 37. The system of radiating lines exerts a distorting effect upon the appearance of the two parallel straight lines. Because of the presence of the two parallel straight lines in Figure 37, the upper arc appears to be the continuation of the curves *a* and *b*, although as a matter of fact these curves are continuations of the lower arc. The theories that have been proposed to account for the influence of these factors are in the main similar to those advanced to explain their effects upon the perception of size.

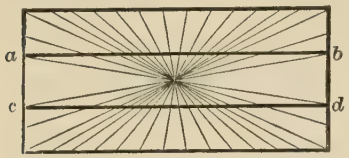

Fig. 36 — The straight lines *ab* and *cd* appear curved because of the presence of the radiating lines.

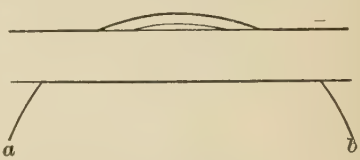

Fig. 37 — The upper arc is perceived as the continuation of the curves *a* and *b*, although these curves are continuous with the lower arc.

Perception of Motion. — The perception of motion is an appreciation of a change of location, and thus motion will be perceived as a consequence of any gradual change in the system of local signs. The perception of motion is relative. An object can be perceived in motion only when some other object is observed as stationary. Every perception of movement thus involves an appreciation of the fact of stability as well. Any gradual change of local signature will arouse the apprehension of motion on the part of one of two objects, but it will give no information as to which object moved and which was stationary. The movement of a visual object toward the observer, for example, involves a gradual alteration of the various local signs of distance, as convergence and accommodation, size,

intensity, binocular parallax, etc., but exactly the same changes will occur if the observer approaches the object. The observer's appreciation of the fact of motion is dependent upon the alteration of these local signs, but any judgment as to whether he approached the object or whether the object moved toward him must be based upon other considerations.

Our judgments concerning the movement and stability of objects are subject to error. A person seated in a train may perceive a car on an adjacent track as moving when in reality it is his own train that is in motion. Likewise the motion of the adjacent car may cause a person to perceive his own train as moving. In the haunted swing illusion, the swing is suspended from a heavy axis that penetrates the walls of a narrow room with a very high ceiling. The swing in which the subject is seated apparently moves with wider and wider oscillations until it finally makes several complete revolutions. As a matter of fact, the swing was stationary and the room was rotated about the axis, the furniture in the room being firmly attached to the floor. When standing upon a bridge and looking down upon a swiftly flowing stream, the observer may experience the illusion of moving up stream. The cloud and moon illusion is a familiar example of an erroneous judgment as to the relative motion of two external objects. The cloud passing over the face of the moon is perceived as stationary while it is the moon that appears to be moving.

Naturally subjects rarely if ever make mistakes concerning any movements that they actively or voluntarily initiate. With the possibility of passive movements, the subject relies upon certain features of his somæsthetic sensitivity in judging whether he is in motion or at rest. For example, if a subject is seated in a train, any sudden

motion on its part will naturally awaken sensations of contact and induce changes of intraorganic sensitivity that are indicative of bodily motion. This latter factor is readily observed during a rapid descent in an elevator. The factors that influence one's judgment as to the motion or stability of external objects have as yet not been adequately analyzed. Knowledge of the character of objects is one factor. The subject knows from his past experience that a swing is a mobile object while the walls of a room are stationary. The factor of expectancy is probably effective in the train illusions. Judgments may also be dependent upon the relative size of the two objects, the tendency being to regard the larger object as stable. In the case of judgments as to the relation between a single object and a group of objects, the observer will probably tend to regard the group as being the stationary factor. The accuracy of judgments is conditioned by the direction of attention. With most subjects, the situation is more correctly perceived when the moving object is fixated. Fixation of the stationary object is apparently more conducive to perceptual accuracy with other observers.

The appreciation of the spatial aspects of objects again illustrates the dependence of perception upon the previous activities of the organism. It also demonstrates the truth of the doctrine developed in Chapter IV that any adaptive response to an object is influenced to some extent by the total sensory situation of the moment. An adaptive response toward an object moving about in the peripheral portion of the visual field may involve a perceptual appreciation of the qualitative nature of the stimulus, its size and shape, its position in reference to the observer, and its rate and direction of motion. In the light of the present analysis, it is apparent that the stimulus to such an act consists of a very complex group of sensory factors.

EXERCISES

1. While listening to a radio with head phones, remove first one and then the other phone to a distance of an inch from the ear, and note the effect upon the localization of the sound.

2. Suppose that an individual should keep one ear thoroughly plugged until he recovers his normal localizing ability. In what respects would this experiment be similar to that of Stratton?

3. Have you encountered any experiences similar to those of Stratton's, *e.g.*, wearing a new pair of glasses, learning to manipulate the slide correctly while observing it through the microscope, learning to guide your acts while observing them in a mirror as in shaving or adjusting a tie?

4. Take some landscape picture, and write out a list of all of the local signs of depth that were employed in creating the illusion.

5. Develop a negative after-image, close the eyes, converge them as though looking at an object held at a short distance in front of the face, and maintain this position until the after-image appears. Repeat the experiment with the eyes held as though looking at an object in the far distance. Can you detect any difference in the size and apparent distance of the after-image for the two conditions? Explain.

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CHAPTER VIII

THE NATURE AND FUNCTION OF IDEAS

Objects of Thought. — An idea or thought, like perception, is a cognitive process in that it involves the apprehension of an object in the interest of some subsequent reaction in reference to it. Thought and perception differ in their objective reference. Present objects are perceived, while absent objects are apprehended by means of thought. Three distinctions are involved in this proposition: — 1. One can perceive only present situations. Past and future events are apprehended by means of thought. 2. Perception is spatially limited. Only a small portion of the universe can be perceived at a given moment. Thought is free from this limitation of space. One can think of distant objects and of perceptually inaccessible situations like the interior portions of the earth. 3. Thought also transcends perception as to kind of object cognized. Perception as a rule apprehends the objective world as given. By means of ideas, one may also regard the world in novel ways. In the realm of thought, it is possible for water to flow uphill and the sun to move from west to east. Neither is thought confined to the world of natural phenomena. One can think of ghosts and fairies and demons as well as of persons and things. Such abstractions and general notions as virtue and infinity, scientific laws and geometrical axioms are also objects of thought. In general, thought functions to supplement and extend the scope of perceptual apprehension and thus im-

measurably increases the possibilities of adaptive conduct.

Kinds of Ideas. — There are three kinds of ideas, — memory, imagination, and conception. One can remember, imagine, and conceive of things. These thoughts can also be distinguished in terms of their objective reference. A person remembers some previous experience of his own in the way in which it occurred. One imagines objects which have not been encountered in actual experience, but which are hypothetical or prospective objects of experience which may or may not be encountered in the future. One may thus imagine some actual object not yet experienced, some non-existential object which may be constructed as a new machine or a new style of dress, or some phantastical object like a cat with horns. Memorial and imaginary objects thus differ in their temporal reference. Objects of memory belong to the past, while imaginary objects can be experienced only in the future. Memorial objects are familiar and actual things, while imaginary objects represent some novel or hypothetical item of future experience. A personal reference characterizes both. In memory, the subject thinks of some item of his previous personal experience, while in imagination he represents to himself the probable nature of a hypothetical or prospective experience. A costume designer pictures to his mind the way a new style of garment will appear to his eye when it is manufactured. In imagining a scenic region which he has never seen, a person is attempting to anticipate and represent to himself in some adequate fashion the probable nature of his perceptual and æsthetic reaction to this situation when he encounters it.

Sometimes the object is overtly recognized and identified as an item of the subject's previous or forthcoming experience. Usually this personal relation is merely taken for granted; the subject tacitly assumes the fact of his ex-

periential contact with the remembered or imagined object. In imagining any event, the subject invariably assumes his own presence in the general background of the imagined situation. Likewise no thought will be labelled an act of memory unless the apprehended event is at least implicitly regarded as having belonged to the subject's previous experience.

Conceptual objects are abstract and general as opposed to the concrete and particular character of perceptual, memorial, and imaginary things. An abstraction is some item or group of items that are apprehended apart from the concrete relations which obtained in actual experience. One can conceive of size and shape as independent of each other; a rectangle as conceived has no definite size. One can think of the pitch of a tone as distinct from intensity and any positional or temporal relation to other items of experience. Obviously pure pitch can neither be perceived, remembered, or imagined; such modes of apprehending pitch must necessarily include some of its relations to other items of experience.

All sorts and degrees of abstraction are possible. Objects may be abstracted from their *spatial* relations. If one visualizes some tree as situated in the spatial environment in which it was perceived, the thought is an act of memory, while any representation of the tree as occupying some novel location in space will be an act of imagination. But it is possible to regard a tree as free in space, *i.e.*, as devoid of any fixed and definite conditions of localization, and in this case the thought is an act of conception. Whenever an object is regarded as free from particular spatial limitations, it must necessarily possess a general and universal spatial significance. Objects may also be abstracted from their *temporal* and *personal* relations. An act of theft

is imagined when it is regarded by the subject as a prospective mode of conduct or as a possible event to be witnessed. But theft may be considered from a purely impersonal standpoint and in this case it is a conceptual object. Class concepts are good illustrations of the abstract and universal character of this type of object. In the concept of animal, the mind is apprehending only those characteristics which are common to all individuals of the animal world, such as life and motility. These attributes have been isolated and abstracted from all those characteristics peculiar to individual animals, and such an object necessarily possesses a universal significance, for any mental reaction to it will also be appropriate to any individual of the class. Objects may be conceived which transcend the limitations of concrete experience. Non-existence, infinity, and the fourth dimension are conceptual objects, but they can neither be perceived nor imagined.

Ideas and Past Experience. — It is a truism of modern psychology that objects of thought are dependent upon and limited by the nature of one's previous experience. Naturally one can remember only those things which have been encountered in the past. Conceptual objects, according to the foregoing account, consist of single items or groups of items which have been abstracted from past experience. Likewise imaginary objects and events are novel combinations of familiar items of previous experience. Let one imagine a tree as situated on the shore of a lake. Both lake and tree may be familiar items of experience, and hence their spatial combination constitutes the only novel feature of the imaginary object. The validity of the contention is quite apparent in such chimerical objects as a mermaid, a cat with horns, and a dog with wings. All inventions and products of creative thought are regarded as

new combinations of the older materials of knowledge. Without prior perception, thought is impossible.

It is instructive to compare this modern doctrine with some of the beliefs of the past. Plato, the Greek philosopher, was unable to believe that such abstract ideals as infinity, virtue, truth, and perfection could be derived from our perceptual experiences of this world. A popular belief of that time was the doctrine of reincarnation. At death, each mental personality passes on to the infinite world and in time is reincarnated in some form in this world. Plato maintained that all abstract ideals are mere memory revivals of the individual's former experience in the ideal and infinite world. It sometimes happens that objects when first perceived impress one as strangely familiar. Such erroneous impressions, according to Plato, are to be explained in terms of the individual's experiences in this world during a previous incarnation.

During mediaeval times, certain ideas and beliefs were regarded as given and innate, necessary resultants of the constitution of mind. A favorite example was the concept of God. The universal prevalence among all races of people of some notion of a divinity was regarded as a sufficient proof of its innate character. Likewise various necessary truths such as the geometrical axioms were assigned a similar origin, *viz.*, the innate constitution of mind. A rather peculiar doctrine of mental inheritance has been advanced by a modern novelist to account for some of the vagaries of dreams. Nearly everyone has experienced the dream of falling and frequently the dreamer awakens before hitting the ground. These peculiar facts demand some sort of explanation, and this writer, dominated by the concept of evolution, assumed that the dream of falling is an inherited revival of the actual experiences of our alleged arboreal

ancestors. The firm establishment of the modern doctrine that all ideas find their roots in sense experience is generally credited to the work of John Locke of the seventeenth century.

Modes of Representation. — In any consideration of the ideational activities, it is quite essential to distinguish sharply between the object of thought and its mode of representation. Absent objects can be apprehended only by some present item of experience which represents or means them. The present item is the means by which we represent or think of that which is not present. Let us suppose that a person is visually imagining some coming event. The visual image is not the object of which the person is thinking. The object of that thought is the subject's future experience of the event, and the visual image is the means by which this prospective experience is represented in the present. Let one visualize the ridiculous behavior of a friend on some given occasion. The thing remembered is the subject's perceptual impression of these acts, while the image is its symbol or representative. Objects of memory are past events; objects of imagination are hypothetical or prospective events and naturally any thought of past or future situations implies that these objects must find some sort of a representative among the mental activities of the present. Some people report that they think of virtue by means of a visual image of a gray-bearded old man with a benign cast of countenance. Obviously this image is but a mental device which symbolizes to their minds those abstract characteristics of social conduct of which they are thinking. Any idea or act of thought may thus be defined as some present process or item of experience considered in its symbolic or representative capacity.

There is no strict agreement among psychologists as to the possible devices that may be employed in thinking of objects, and the following statements must be regarded as an expression of the author's opinion. All objects of thought are represented by means of some sensory or imaginal processes or a combination of the two. Any kind of image or sensation may serve this function. The representative activity may be quite simple or relatively complex in character. A visual image was employed in the illustrations cited in the previous paragraph. Some people can also use auditory and other forms of imagery on occasion. Thinking by means of linguistic or verbal activities is quite common, and these word symbols may be either visual or auditory images on the one hand or vocal activities of a sensory character on the other. This latter method of thinking of an object by vocalizing its name is quite common and it is used much more extensively than one ordinarily suspects; the person thinks by talking silently to himself, and often these incipient movements of the throat and lips may be perceived by an observer. Naturally these laryngeal activities in many cases are sensory processes rather than kinæsthetic images.

In spite of a widespread fallacy to the contrary, the representative or thought activity does not need to be similar to the thing which it signifies. Some degree of resemblance does obtain in certain cases as when one thinks of the visual aspect of an object by means of a visual image, or of some sound with an auditory image. But any similarity or resemblance is lacking when the object is represented in linguistic terms. Obviously the vocalizing process is not the object of apprehension and neither does it bear any resemblance to the object it signifies. Any resemblance is necessarily precluded in the case of such conceptual

objects as infinity and the fourth dimension. Another illustration of the same principle is the method of representing virtue as cited in the previous paragraph. The reader is now able to appreciate the proposition, enunciated in the discussion of imagery (p. 129), that the existence of imagery can not be inferred from the character of the object of thought; the ability to think of all sorts of odors does not justify the assumption of the existence of olfactory imagery.

Individuals differ quite radically as to their modes of representing objects, while each individual, it has been assumed, varies but little in this respect. As a consequence there has been formulated the doctrine of mental or ideational types, — the assumption that individuals can be classified according to their usual method of representation. A visual type of mind is one that employs visual imagery. Those individuals who utilize auditory imagery are termed audiles. The verbal type includes those persons who think in terms of words, and this group may be subdivided into the three classes of visual-verbal, auditory-verbal, and vocal. The existence of various mixed types is generally recognized. In a mixed type the representative activity is complex and consists of a combination of different processes. A person who uses the laryngeal activities in conjunction with visual imagery will be classed as visual-vocal. The doctrine of types must not be taken too seriously, as the representative activity is quite complex at times and with many individuals the method of thinking varies with circumstances. The conception of types is useful in the main for characterizing the more usual and predominant features of any individual's methods of thinking.

It is a noteworthy fact that trained and competent ob-

servers are frequently unable to state their modes of representing certain objects. The subject is perfectly aware of what he is thinking, and he is duly cognizant of an extensive background of sensuous and imaginal material, but he is wholly unable to assert with any assurance that the object of thought is represented by any of these items of experience. This fact has induced some psychologists to deny the proposition that objects of thought are invariably represented by means of some sensory or imaginal processes, and hence to assume the existence of some third kind of representative device. Such a conclusion is wholly unnecessary, for it is entirely possible and in fact quite probable that a sensory or imaginal process may serve to represent a given object without the subject's being aware of that fact. The general principle may be readily illustrated from the field of space perception. A naïve observer, required to estimate the distance of sounds while blindfolded, will be totally unable to state the experiential data upon which his judgments were based. If specifically questioned, many of these subjects will deny that their judgments were influenced in any manner by the intensity or tonal complexity of the sound, and yet the efficacy of these factors can be demonstrated in a convincing fashion by experimental means. Logical results can thus be mediated by sensory data and the subject be perfectly oblivious of the fact.

A thought involves the partial and indirect arousal of a perceptual-motor system of experiences. A perceptual system consists of a large number of diverse experiences which have become habitually associated or integrated into a functional unit. Any perceptual system may be indirectly and hence partially aroused in virtue of its associative connection with some other stimulating object. The predominant features of one's perceptual reaction to some friend

are the various visual experiences of his postures and characteristic facial expressions, the auditory impressions of his voice, and the visual, auditory, and articulatory experiences of his name. Let us suppose that this unitary system be indirectly excited by the sight of his home. If only the optical mechanism is excited in this manner, a visual image of the person or of his name will be aroused. Stimulation of the auditory mechanism will give an auditory image, and the excitation of the articulatory component will arouse a sensory process. It is also possible for any two or all three of these components to be excited. According to the principles developed in Chapter VI, any component of an associative unit, whenever stimulated, may exhibit a meaning which is a function of the entire associative system. This friend can thus be thought of or represented by means of a visual image, an auditory image, a vocal sensory process, or any combination thereof. Any essential component of a perceptual reaction to a given object when indirectly aroused may serve as a symbol or representative of that object, and the more complex the perceptual system, the more numerous will be the possible modes of representation.

The general principle just developed at once suggests the possibility of representative devices other than those already enumerated. Many perceptual objects excite certain characteristic motor and organic reactions, and any indirect revival of the essential features of these responses may play a part in the representation of those objects. The perceptual experience of an attractive food consists of visual, olfactory, gustatory, and cutaneous impressions together with a characteristic response toward it. Consequently this edible object may be thought of by means of visual, olfactory, gustatory, or cutaneous imagery, or in

terms of a partial reinstatement of this organic reaction. In order to think of a severe pain in any vivid fashion, some people find it necessary to reinstate several of the more important features of the motor and organic effects of such a stimulus.

Again, any perceptual reaction to an object includes some attentive adjustment of the sense organs, and these motor activities are frequently aroused in thought and serve to signify in part the sensuous character of the object. A vocal process is an essential component of nearly all of the author's representative devices, but in addition to this element, he finds it necessary to employ an ocular adjustment when he desires to think of the visual aspect of a bell and an auditory adjustment to apprehend it as a sounding object. These sense organ adjustments are also frequently employed as a means of thinking of the location of things. Let one imagine a visual object at a distance of fifty feet, and then suddenly think of it as located within a few feet of the face. A very pronounced convergent strain can usually be detected as a result of this effort. Likewise some appropriate adjustment of the body, head, or eyes can usually be observed when one quickly imagines an object as located to his extreme right or at some distance directly over the head.

The well-known phenomenon of muscle reading is based upon the fact that a thought of the location of an object naturally involves some appropriate adjustment of the organism in reference to that position. The experimenter is blindfolded. Some object in the room is placed in a new position. Two persons are asked to grasp the experimenter's wrists and to keep intently thinking of the object's location. By groping about with the hands and moving forward in the direction of least resistance, the position

of the object may be readily discovered. Many people are prone to use various facial expressions and gestures in expressing their thoughts to others, and naturally such people may employ these motor activities in thinking for themselves. Many people are able to think of yes and no by means of slight movements of the head. In fact, language might well be defined as a device for thinking publicly, — to express thoughts to others, and naturally there is no reason why the same devices should not be employed in thinking privately. A young lady, who had occasion to use the deaf-mute language quite frequently since early childhood, once informed the author that a considerable portion of her thinking was carried on in terms of slight movements of her fingers. As a final example of the devious ways of thinking, witness the extent to which children use their fingers as symbols in numerical computations. Practically any item of experience is capable of being used in the service of thought.

How Distinguish between Cognitive Activities. — Inasmuch as perception and thought may involve either a sensory or imaginal process with its attendant meaning, the two differ in respect to the type of reaction which these processes elicit. In perception, the sensory or imaginal stimulus is attentively examined from the standpoint of its significance for conduct, while in thought it is *what* this stimulus means that is regarded as the potential object toward which to react. In the case of thought a vocal activity may be utilized to symbolize a coming event and arouse some preparatory adjustment in reference to that prospective situation, while this vocal process will be perceived when it is attentively examined as an object of scientific knowledge. The sensations of hunger may be perceived, or they may stimulate us to think of food without

being perceived. A person may use images as representatives of non-perceptible objects, or he may react to these images as objects of scientific study. One may first perceive an object and then react in reference to what that object signifies. For example, upon returning home, a person may notice a hat in the hall which is perceptually identified as the property of a friend, and it is this friend in the parlor, rather than the hat, that now dominates the individual's behavior. The perceptual object thus serves as a stimulus to arouse a thought of an associated object. The mind may thus pass rapidly from perception to thought, from thought to thought, and from thought back to perception, and these rapid transitions represent the normal course of one's cognitive activities.

Neither can acts of memory, imagination, and conception be distinguished in terms of the kind of representative device employed. Possibly linguistic devices are better adapted and more frequently used for the representation of highly abstract objects, yet all such objects can be thought of by means of symbolic imagery. The manner of thinking of virtue as previously cited is a good example. Imagery is not even essential to an act of imagination as the word suggests. Prospective situations and events can be symbolized in vocal and sensory terms. People wholly devoid of imagery seem to encounter no difficulty in thinking of any sort of imaginary object. Memorial objects may likewise be apprehended in terms of images or sensations.

Memory and imagination are primarily distinguished in terms of certain habit characteristics. Imaginary objects consist of a novel arrangement of the items of past experience and hence every act of imagination violates or runs counter to habit in some respect. An act of memory on the contrary conforms with habit. Let the reader seriously at-

tempt to visualize a square saucer, a purple sheep, a horse galloping backwards, a dog with wings, a giraffe without a neck, or some friend as four inches tall. Any concrete representation of these objects comes slowly and with effort, and when attained it is very unstable and quickly vanishes or reverts to a more habitual norm. Ideas of such objects do not arise in any spontaneous fashion. Contrast with the above the ease, the speed, the stability and persistence of the representation when you think of those objects in a habitual manner, *i.e.*, the saucer as round, the sheep as white, and the horse as galloping forward. While thinking of our presidents, let one suddenly enunciate the words George Lincoln and note the hesitation, indecision, and effort involved in the transition as compared with pronouncing George Washington or Abraham Lincoln. Imaginary objects can thus be identified in the very act of representing them. In attempting to remember the date of some historical event, several possibilities are often suggested, and the correct association may be selected on the basis of the greater ease, celerity, and smoothness with which this date can be enunciated in conjunction with the event in question.

When any imaginary object, *e.g.*, a mermaid, is frequently represented, it naturally loses its novel and non-habitual character and it can not be identified on this basis. In this case, the several items of the novel object may suggest a series of conflicting or incongrous associations which serve as the basis of its identification. Likewise the object may be identified by means of memory; the subject remembers that the object was originally labelled as imaginary.

Objects of memory and imagination are not always correctly distinguished. People may assert that they remember things which never occurred and they may regard as

imaginary certain events which have actually transpired. This fact of confusion is explicable in terms of the habit conception. Children are more prone to error in this respect than adults, and naturally memorial and imaginary events can become differentiated in terms of habit only with the growth of experience.

Let a person be called upon to give legal testimony concerning some event which he casually witnessed several months previously. In mentally reviewing the various details of the occurrence, many possibilities will naturally be suggested and the problem confronting the subject will be that of distinguishing between those which occurred and those due to imagination. Owing to the casual nature of the original observation and to the passage of time, the two orders of events can not be readily distinguished on the basis of their habitual characteristics. The subject's first attitude toward many of these suggested details will be one of frank doubt. Let us assume that the witness has a personal interest in the outcome of the trial and that the verdict will depend to some extent upon the nature of his testimony concerning several of these doubtful details. This interest may suffice to allay the attitude of doubt and induce an initial memorial bias toward an imagined circumstance. Naturally the subject's mind will keep reverting to this circumstance, and according to the principle of habit this initial memorial attitude toward the event in question will be strengthened in proportion to the frequency with which it is apprehended.

Likewise one may develop a confident disbelief in the memorial character of certain recollections. It is thus entirely possible for witnesses in all sincerity to give a confident memory report of circumstances which never occurred. These confusions are relatively rare events, how-

ever, and as a rule the error is detected in the course of experience without entailing any very serious effects upon conduct. Popular thought is inclined to regard these confusions as an amazing and mysterious sort of phenomenon that necessitates an unusual type of explanation. As a matter of fact, the truly remarkable feature of mental life is our ability to distinguish between these two types of object as readily as we do.

As a basis for the distinction between abstractions and the concrete objects of memory and imagination, it was once suggested that a class concept involves an image somewhat similar to a composite photograph, *i.e.*, one which represents all the details of each individual of the class. Generic or schematic images have also been suggested as the usual device for representing class concepts; such an image is supposed to contain only those items which are common to a class of objects. Such suggestions are hardly feasible in view of the fact that a conceptual object may be represented by a verbal symbol and that the same word may signify the class concept or any individual of that class. A more fruitful hypothesis is the suggestion that the conceptual significance of a representative process is mainly a function of its relation to the context of activities of which it is a part. As previously suggested, freedom from specific contextual relations is indicative of a universal significance (p. 167). When thinking is carried on in vocal terms, the particular or general meaning of a word like horse may depend in part upon certain peculiarities of enunciation and intonation but in the main the character of its meaning will be a function of the linguistic activities that precede and follow it in the course of thought.

Arousal of Ideas. — According to the conventional doctrine of psychology, an idea of a given object can be

aroused only in virtue of its association with some preceding item of experience, and this association between the two factors must be regarded as having been established in the past. The emergence of an idea must thus be conceived as a consequence of the subject's previous organization of experience. Such objects as pencil and paper have been frequently experienced in connection with each other, and as a consequence the perception or thought of one object may now arouse an idea of the other. The arousal of an idea may thus be regarded as a response to some preceding item of experience as its stimulus.

Ideas are frequently suggested by some preceding idea. The one idea is aroused in virtue of its associative connection with a preceding idea, and this idea in turn was aroused by an idea that preceded it, and likewise this latter idea was aroused by something that had previously occupied our thoughts. Such a sequence is termed an associative chain or series of ideas. Such an associative sequence fails to account for the arousal of ideas, for we still have to account for the arousal of the initial member of the associative series. Obviously, the doctrine of association must assume that every idea or associative train of ideas is aroused in virtue of its associative connection with some item of the sensory situation in which the thought occurred. Ideas can be aroused only by the incidence of some stimulus upon a sense organ, and if it were possible to exclude all forms of sensory excitation for a short period of time the capacity for thought would cease for the moment. This doctrine is in harmony with the previously enunciated principle that all forms of mental activity are elicited by sensory stimuli (Chap. IV). The doctrine assumes that it is theoretically possible to trace every idea or train of ideas back to the suggestive influence of some sensory

stimulus of the moment. The reader must note that ideas may be aroused by intraorganic stimuli, — by hunger and thirst and the various kinæsthetic stimuli involved in our movements and bodily postures as well as by stimulations from the external world. The doctrine does not assert that our capacity for thought is wholly dependent upon the character of the objective environment in which we find ourselves.

Present-day psychologists, for the most part, are disposed to accept the doctrine that all ideas are aroused by means of association in spite of the notorious fact that no one is able to trace every train of thought back to some sensory source. This fact, however, does not disprove the associational hypothesis, for the dependence of a mental event upon some aspect of the sensory environment can be readily demonstrated by experimental means although this relation may escape the most careful scrutiny of a skilled observer (p. 144).

Every one admits that the great majority of our ideas are aroused through association. Some people deny, however, that association can account for all cases of revival, and hence additional possibilities of arousal have been suggested. For example, the doctrine of telepathy assumes that one mind can influence another mind in the absence of any known sensory connection between them. In other words, ideas can be aroused through non-sensory channels. Likewise spiritualistic mediums assert that their minds are subject to the influence of supernatural agencies by the way of non-sensory avenues. Orthodox psychology regards the evidence for such assumptions as unconvincing. The doctrine of the spontaneous arousal of ideas has also been advanced. One noted psychologist in times past regarded ideas as active entities or forces which are continually

striving for conscious expression. He assumed that ideas are mutually interactive forces which tend to inhibit each other's emergence from the subconscious realm of mind. According to this conception, any idea will spontaneously arise unless it is prevented from so doing by the dominance of other ideas. Much the same conception is found in the modern doctrine of perseveration which assumes that an idea may spontaneously reoccur for some time after it has been vividly excited. This conception is well adapted to explain the occasional arousal of ideas that apparently are totally unrelated to the situation in which they occur.

According to the associational theory, the character of a person's thought at any given moment is a function of his organization in reference to the immediate sensory situation which includes intraorganic as well as extraneous sensory stimuli. Objects become associated with such intraorganic conditions as hunger, thirst, and the various moods and emotions, and the occurrence of any of these sensory conditions may awaken a train of thought. Objects also become associated with various muscular movements, and hence ideas may be aroused by the cutaneous and kinæsthetic stimuli involved in performing these acts. Objects may also become associated with certain bodily postures and facial expressions, and the recurrence of these attitudes may awaken thought. The sight of our feet, and hands, and clothing may also exert a suggestive effect upon the course of thought. Obviously we can regulate the course of our thought just in so far as we can control these intraorganic factors or determine the character of our objective environment.

While all aspects of a given sensory situation may exert some effect upon the course of thought, not all components are equally effective. The ideas suggested at any given

moment are in the main a function of the motivating stimulus, the objective or goal of adjustment, the nature of the adaptive response, the direction of attention, and the character of the associations that have been established with this or similar behavior situations in times past. The possibilities of recall at any given moment are thus extremely restricted, and naturally the ideas that emerge in any given behavior situation are for the most part pertinent or relevant to the temporal exigencies of that situation. The thoughts that occur to a football player during a game are usually pertinent to the various behavior situations that arise, and a salesman generally thinks of but little that is not germane to the task at hand. In other words, the thoughts that arise in any situation are usually valuable in effecting a more adequate adjustment to that situation.

Irrelevant and distractive ideas do arise during the performance of an act. These ideas are occasionally suggested by the act itself, but for the most part they are due to the suggestive influence of some feature of the wider sensory environment. Such an idea may possess a sufficient dynamic strength to disrupt the act in question, and arouse a response adapted to the situation which that idea represents. In other words, a new behavior situation has arisen, and this new situation in turn will dominate the further trend of thought.

Function of Ideas. — An idea, like perception, is a dynamic as well as a cognitive process. An idea not only represents an object, but it acts as a stimulus and exerts some dynamic influence upon the general trend of mental events. An idea represents the indirect and partial arousal of our system of perceptual-motor experiences, and hence it may arouse any of the responses that are associated with

these percepts. An idea is a substitute for a perceptual stimulus. A person thinks of objects when their perception in the nature of the case is impossible, or because a thought serves the same purpose in a more economical or effective fashion. Ideas, like perception and other mental events, are experiential activities of the organism that involve the release of neural energy and hence they must exert some effect upon the behavior situation in which they occur.

The stimulating possibilities of an idea are a function of the nature of the object and the character of its associations. An idea may stimulate the arousal of another idea or train of ideas. The thought of Napoleon may cause one to think of Waterloo and St. Helena. Ice and skates, snow and sleds, silver and gold, rat and cat, pencil and paper, and Lincoln and Gettysburg represent very intimate associations, and the thought of one member of a pair is likely to suggest the other when the circumstances are at all propitious. Ideas may also arouse various moods and emotional attitudes. The memory of a recent bereavement is likely to induce a genuine sorrow. The thought of certain objects is apt to arouse an attitude of loathing and disgust. A maiden may be more thrilled by the thought of her coming wedding than by the event itself. The inruption of an idea may merely distract, inhibit, or accentuate the activity in which one is engaged at the moment. A frivolous student occupied in the preparation of a lesson is easily distracted by the thought of a more exciting line of endeavor. A boy diligently engaged in some mischievous behavior may be momentarily deterred by a thought of parental disapproval. A person's endeavors in some monotonous task may be temporarily energized by the thought of its advantageous consequences. An idea may also elicit an act that is adapted to the objective situation which that

idea represents. The thought of a coming lecture may induce a more adequate preparation for that event. In walking through a city at night, a person will choose a roundabout path to reach his destination because of his knowledge of certain dangerous quarters. In general an idea may awaken any type of reaction.

Any idea is thus a stimulus to a great variety of potential responses. The degree to which a given idea affects us and the character of the response elicited are functions of the ever varying circumstances in which the thought occurs. In one situation an idea may awaken a train of ideas, while under other circumstances it may arouse a mood, energize the act in which we are engaged, or elicit a response adapted to the object represented. In certain behavior situations, a given idea may exert very little noticeable effect upon what we are doing, while at other times this same thought may completely dominate our conduct. In order to demonstrate the dynamic character of ideas, instructors often request their students to think of a number of specified objects and note the stimulating effects of these ideas. Naturally many ideas will exert but little effect under such arbitrary and irrelevant conditions, and consequently the experiment has induced some degree of scepticism concerning the validity of the doctrine. Obviously the thought of a hammer will influence a person's conduct in any overt fashion only when he has need for such a tool. The thought of food will energize one to action only when he is hungry. Under most circumstances a person can imagine with perfect equanimity a tiger as crouching for a spring, but the occurrence of this same thought while in the wilds of India will exert a paralyzing effect upon conduct. One can also think intently of an act without performing it, and yet this thought will arouse the act in question when such behavior is

relevant to the situation at hand. In general the type of response which any thought elicits is usually relevant to the behavior situation in which it is aroused.

Thought serves much the same purpose in adaptive conduct as does perception (p. 132). 1. Objects of thought may constitute the end or goal of conduct. By means of ideas, we are able to act so as to attain or avoid some *remote* end. With the advent of ideas, the organism is no longer constrained to react in reference to the world as perceived. Any object in the whole realm of space may serve as the goal of conduct. By means of ideas, present acts may be organized so as to prepare for and meet all sorts of future contingencies. By means of thought, we can apprehend the world in novel ways and act so as to reconstruct and transform it to suit our own purposes. We build bridges, irrigate the deserts, and invent and construct new machines to do our bidding. 2. We also think of and act in reference to objects as a means of attaining other ends. For example, an individual may think of the location of a hammer and go and find it in order to use it as a means of furthering some perceptual-motor task in which he is engaged. Thought is frequently employed to supplement the inadequacies of our perceptual-motor adjustments, 3. Finally ideas may represent movements and their consequences. By means of thought, an individual may consider the various possibilities of reacting to a prospective situation and make some decision as to the most appropriate and effective way of dealing with that situation before encountering it. Numerous illustrations of these values may also be found in the subsequent chapter. In general thought immeasurably increases the possibilities and effectiveness of our adjustments to the world.

EXERCISES

1. Can you supply from your own experiences any decisive and convincing evidence that ideas are not always aroused by the present sensory situation? Is any answer to this question of the relation of thinking to the sensory environment somewhat of an assumption? See Chapter IV.

2. Can you cite any ideas that you have had that can not be regarded as revivals or reconstructions of your previous experiences?

3. How would you account for the universal prevalence of certain ideas without assuming their innate origin? See Chapter XVI.

4. How would you account for the fact that objects seen for the first time may impress one as strangely familiar? Cite any such experiences that you may have had.

5. Does false legal testimony necessarily constitute an act of perjury? Cite any experiences that you may have had of remembering things that never occurred. Give any illustrations of regarding as imaginary things which you have actually experienced.

6. Explain in terms of habit and association why it is possible to think of objects by means of vocal activities.

7. Think intently for several moments of the appearance of a rainbow, the sound of a bell in the distance, a throbbing tooth, a pain in your ear, the movement of your tongue in pronouncing "cat," a horse as galloping backward, a purple sheep, the aroma of coffee, the taste of vinegar, a thimble located on the top of your head, generosity, motility, non-existence, and the centre of the earth.

8. Write out a complete statement of the images, vocal activities, organic processes, and motor attitudes and tensions that were involved in thinking of each of the above objects. Can your mode of representing an object vary from time to time? Does it vary with the object?

9. Classify the above objects as memorial, imaginary, and conceptual. Can any of these objects, *e.g.*, the aroma of coffee, be regarded as memorial by one individual and imaginary by

another? Can you discover any distinctive differences in your modes of representing the three kinds of objects?

10. State the various respects in which thinking conforms to our definition of a mental act.

11. Compare the function of thought with that of perception.

12. Can a memorial revival of your perceptual experiences of an object involve an abstraction from its spatial associations, its temporal associations, or its personal associations?

13. Does the conceptual revival of experiences necessarily involve an abstraction from their personal associations, their temporal associations, or their spatial associates?

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CHAPTER IX

REASONING

A person thinks in so far as he utilizes ideas in reacting to situations. Since ideas are derived from and represent past experience, thinking is a mental act (p. 1) because it represents one of the ways in which the effects of past experience are utilized in the guidance of conduct. As developed in the previous chapter, thinking is necessarily involved in the performance of many acts of adjustment. Ideas may also be employed in the acquisition of a new adjustment to a problematical situation, and this special type of thinking is known as reasoning. Reasoning may thus be defined as the process of solving problems by means of ideas, or as a rational or ideational method of acquiring or learning a new adjustment.

The Rational and Motor Methods of Solution. — For the purpose of a preliminary analysis, reasoning may be contrasted with the motor method of learning (Chapter V), since a human being may employ either method in the solution of a perceptual problem. The dog reacts to the cane and fence situation by trying out in a random order all those responses which he has previously acquired in dealing with similar problems. He experiences the sensory consequences of each act and varies his behavior in accordance with those consequences until the successful response is discovered by chance. Let us suppose that the dog can think, or rather let us imagine that a human being,

endowed with the dog's equipment of habits, is confronted with this situation and attempts to solve it by means of reason. Our hypothetical subject will refrain from acting in any overt manner, and attempt to imagine what will probably happen in case he should perform a given act. Each suggested act will be ideationally apprehended in terms of its adaptive relation to the objective situation, and the subject will modify his subsequent procedure on the basis of this knowledge. One ideational attempt will suggest another until the subject happens to think of an act that is deemed appropriate, and this thought will then arouse the act in question. As previously stated (p. 185), the thought of an act will arouse that act whenever such behavior is regarded as relevant to the situation of the moment. After performing the act, the subject may discover that his judgment of its adaptive character was erroneous, and the ideational quest for a solution is then continued until the subject discovers an act which he believes to be appropriate and this belief is verified by the successful performance of that act.

We may likewise compare the two methods as applied to the solution of a mechanical puzzle. With the motor method, the subject twists and pulls and manipulates the apparatus in a hit or miss fashion and perceptually notes the consequences of each act. When reason is employed, the subject refrains from acting, perceptually analyzes the situation, and thinks of what will happen in case he should act in a given way. The solution is discovered by means of movements in the one case and by means of ideas in the other. In one method the subject learns by doing, and in the other by thinking.

The two methods of adjustment are identical in most respects. Both involve a motivating problematical situa-

tion, a variable, persistent, and analytical mode of attack which is continued until the solution is more or less accidentally discovered, and a series of repeated trials to perfect and fixate the correct response. In both cases the problem is solved in terms of previous experiences acquired in dealing with similar situations. The motor method involves a series of overt responses to a perceptual situation, while reasoning is primarily characterized by the fact that it employs ideas as substitutes for or representatives of those movements or percepts. In the simpler types of reasoning, as in the illustrations already cited, the subject utilizes ideas as substitutes for the movements and their attendant consequences, *i.e.*, he thinks of these movements instead of performing them. In the higher types of rational process (p. 210), both the objective situation and the series of responses are ideationally represented, and the whole process of adjustment is mediated in terms of ideas. Obviously the possession of ideas and the ability to reason are correlated phenomena.

Limitations of Reason. — Reasoning is subject to some serious limitations, and in these cases a person is compelled to rely upon the motor method for a solution. Contrary to popular opinion, the motor method is distinctly serviceable and is quite extensively employed in human adjustments.

First, the motor method must necessarily be employed by a child prior to the development of ideas. All habits established during the first few years of life are acquired in this manner. Walking, talking, and the ability to handle objects are examples. The motor is the primitive and fundamental method, and reasoning is the derivative process.

Many situations are encountered all through life which are of such a nature that the consequences of a proposed response can not be anticipated, and naturally reasoning

can not be employed in such cases. A person confronted by two diverging paths in walking through an unfamiliar stretch of woods obviously lacks the requisite experience for making a rational choice between them. A complicated puzzle box which is opened by the operation of a concealed mechanism offers no opportunity for a rational solution. The stylus maze problem (p. 86) is also one which must necessarily be solved by the motor method.

The consequences of a proposed act may be so complex that they can not be successfully apprehended in thought, and the act is then partly performed as a means of further analysis. In playing checkers, one may partially perform a proposed move which involves much trading in order to apprehend its results in a more adequate fashion. Graphical means of analysis are usually found necessary in testing a proposed solution of a geometrical problem. Likewise a machinist, in designing a complicated bit of machinery, usually finds it advisable to resort to a drawing or to the construction of a model in order to test the value of his conceptions.

The motor method is frequently useful as a means of discovering a suggestive clue for a further rational attack. A person first attempts a rational solution of a puzzle problem but in the event of continued failure he usually resorts to a series of random manipulations in the hope that some chance occurrence will suggest the proper mode of solution.

The Advantages of Reason. — Reasoning is the better method when a person is confronted with a situation which involves consequences of a dangerous or harmful character. The detrimental effects of many fruitless acts may thus be avoided.

Reasoning often saves time and energy. Let us assume

that a process of reasoning duplicates exactly the various steps of a motor solution. Inasmuch as an act can usually be represented more quickly and easily than it can be performed, the rational method will involve a less expenditure of energy.

Reasoning also involves an economy of materials in all constructive types of problem. Any frequent alteration or modification of one's plans during the process of constructing a house will naturally entail a considerable additional expense. Any trial and error method of designing and constructing a complicated machine is obviously a wasteful mode of procedure. In fact, a more thorough application of rational foresight to the various problems of industry would effect a tremendous saving.

Reasoning is the superior method in that it can utilize a much wider range of experiential data in the solution of a problem. Reasoning employs ideas, and ideas imply language, social contact, and the interchange of knowledge. With the motor method the subject is forced to rely exclusively upon the system of perceptual-motor habits which he himself has acquired in dealing with similar situations, while in reasoning he can also draw upon the experiences of his fellows in effecting a solution. The rational possibilities of an individual are thus to a considerable degree a function of the character and extent of his social contacts. One can hardly overestimate the degree to which man's adaptive capacity is dependent upon these social contacts. A hypothetical Robinson Crusoe, reared and living in isolation, would be capable of but little rational achievement. Society preserves, evaluates, and disseminates by various channels the accumulating wisdom of the race. A human being is freed from the necessity of solving the various problems of life wholly in terms of

his own individual experience. Society involves coöperation and division of labor; each individual is concerned with a very restricted group of problems, and for their solution he has at his disposal the accumulated knowledge of his social group. In no line of activity does a person rely exclusively upon his own experience. In the care and rearing of her infant, the young mother uses information based upon the experiences of her parents, her circle of acquaintances, or obtained through reading or by consultation with her family physician. A person before entering upon such a profession as engineering, dentistry, or medicine must acquire and master a certain amount of knowledge and technique which has been developed in the practice of those professions. The acquisition of knowledge through any social avenue involves the use of ideas, and the application of this ideational knowledge to the concrete conditions of life necessarily involves some degree of reasoning.

Reasoning is again the superior method in that it is applicable to a much wider range of problems. The motor method can be employed only in the solution of a perceptual problem. The dog can solve the cane and fence problem only when actually confronted with that situation, only while it is being perceived. Reasoning can be utilized for both perceptual and ideational problems. In reasoning, the problem does not need to be present to sense; it may be ideationally represented. A rational subject may encounter a concrete situation and fail to solve it, and then recall that problem at some subsequent time and effect a solution by means of memory. One can also anticipate fairly successfully a limited number of prospective situations and work out satisfactory solutions before encountering them. A successful business man is accustomed to

anticipate the probable exigencies of the morrow and to decide in advance what may be the best method of meeting them.

Reasoning is also involved in the solution of conceptual problems. For the most part, the concrete problems of life can be anticipated only in a very general and schematic way. A person embarking upon a medical career can have only a very general and conceptual notion of the character of the concrete situations which will arise in his professional practice. These situations can be solved in advance only in so far as they can be conceptually apprehended, and this partial solution consists of the discovery of certain general principles which are applicable to a wide group of potential conditions. Reasoning in conceptual terms thus enables a person to solve in part the prospective problems of life, and the completion of this rational process consists of the application of these general principles to the various concrete situations that are subsequently encountered.

Reasoning is also concerned with the more highly abstract and theoretical problems of the natural sciences, mathematics, history, politics, religion, and ethics. Such problems are concerned with the further analysis, elaboration and evaluation of existing knowledge as well as with the discovery of new data. No matter how abstract and abstruse many of these problems appear to be, they must be regarded as having been derived from less abstract conditions, and eventually they must find their genetic origin in some of the concrete problems of human conduct. Moreover, the significance of this type of rational activity must be regarded, in the long run, from the standpoint of its prospective utility in effecting a more adequate adjustment to the various concrete conditions of life.

There is an old adage that ' a person should not cross a bridge before he reaches it.' Regarded as a universal rule of conduct, such an admonition is wholly indefensible. Crossing bridges in advance, partially solving the prospective problems of life constitutes one of the prime functions of the rational process. Education has been defined as a preparation for adult life. Especially is this statement valid for all professional training. In securing a medical education, the student is acquiring a ready-made system of partial solutions for the various exigencies which he may be expected to encounter in the practice of his profession. The value of such rational operations is obvious. A man's vocational efficiency is a function of his preparation for those tasks. One's speed and success in meeting the novel situations of life are proportional to the degree to which these problems have been anticipated and solved in advance. Moreover, many situations that are encountered demand a more or less immediate response. Time and tide wait for no man. Such problems must be solved and reacted to at the time of their occurrence. Any extended delay is fatal to success, and naturally any individual will be at an advantage who is equipped to meet these exigencies as they arise. A person who refuses to anticipate and prepare for future events, who is content to live wholly in the present and meet each new situation only as it occurs can hardly be termed a rational being.

Reasoning is again the superior method in that this type of solution usually requires fewer trials for its fixation. There are two possible explanations for this fact. 1. In both reasoning and the motor method, the phenomenon of selection and elimination is due to the differential character of the consequences of the right and wrong responses respectively. With the motor method, the consequences of the

acts, or their adaptive relation to the situation, are perceived, while in reasoning they are apprehended by means of ideas. The latter mode of apprehension involves a greater amount of knowledge concerning their character. With the motor method, the subject may discover the mere fact that an act is not adapted to the situation without understanding the reason for its failure. The dog perceives that the cane will not pass between the pickets but does not know why. The ideational apprehension of the non-adaptive character of an act, on the other hand, will necessarily involve some knowledge as to why it is not adapted to the situation. Since acts are selected or rejected in terms of their consequences, it is suggested that the effectiveness of these consequences will be proportional to the subject's knowledge concerning them. 2. The rational solution of a perceptual problem involves an additional selective factor. In reasoning, the successful and unsuccessful responses are further differentiated by the fact that the unsuccessful responses are merely represented by means of thought, while the successful act is first imagined and then performed, and it may be suggested that this additional and more vigorous exercise of the appropriate response will increase its likelihood of recall upon subsequent occasions.

It is sometimes asserted that reasoning is the superior method in that it is the more systematic mode of procedure. It is assumed that the adoption of the rational method will reduce to a considerable extent the number of unsuccessful or fruitless attempts, and as a consequence that the solution will be discovered in a more expeditious fashion. The several arguments advanced in support of this proposition are not altogether valid.

1. It is alleged that an unsuccessful attempt is never

repeated as is the case in the motor method. An exhaustive analysis of all the consequences of each proposed solution is not the rule, and, in the event of failure after a series of attempts, the subject is quite prone to return to their reconsideration in the hope of discovering some possibility which had previously eluded analysis. Reasoning may involve less repetition but the difference between the two modes of procedure is slight.

2. Reasoning involves some understanding of *why* an act is not adapted to the situation, and it may be supposed that this sort of knowledge will naturally suggest the correct solution of the problem and hence materially reduce the number of fruitless attempts. The suggestive effect of this knowledge will vary, however, with the character of the act. An understanding of why the cane will not go through the fence when carried in the usual manner might suggest the proper corrective procedure, but a similar understanding of the defectiveness of the other modes of attack such as jumping over the fence or seeking a gate will certainly not do so. In fact such knowledge is likely to be detrimental in its suggestive effect.

3. One may also assume that it is easier to think of a novel act than to perform it, and hence that solutions will be more readily discovered in ideational than in motor terms. The validity of this assumption may also be questioned. Let us suppose that a group of a thousand persons be requested to visualize a tree. Not once will the object be represented as upside down with its branches on the ground and its roots in the air. The reason is obvious. An idea involves the indirect excitation of a perceptual-motor habit (p. 167), and hence one naturally thinks of objects as they are customarily perceived. Likewise, one naturally thinks of acts as he is accustomed to perform them. Given

the dog's inveterate habit of always grasping the cane in the middle, our hypothetical rational subject would be no more likely to think of the solution of this problem than to discover it by motor means. The student must avoid the naïve assumption that reason represents some mystical power of mind that enables a person to discover solutions in a direct and intuitive manner.

Reasoning, like the motor method, involves a problem, the search for a solution, and a process of fixation, and we shall now discuss these three features of the rational process in a more detailed and systematic manner.

The Problem. — Reasoning may involve either a perceptual or ideational problem. The conditions under which perceptual problems arise were stated in Chapter V. Inasmuch as the same description is applicable to problems of thought, these conditions need not be stated again.

The number of problems that can be solved by reason is almost indefinitely increased with the development of thought.

Ideas transcend the time and space limitations of perception. With reasoning, a person can adapt to distant situations, solve the prospective problems of life, and deal with the various conceptual problems of history, science and philosophy. Any aspect of the universe is a potential object of thought.

Man's wants and desires indefinitely increase with his ideational development. With the development of thought, man's desires soon outstrip his capacity to satisfy them.

Ideas also increase the possibilities of conflicting modes of response. Ideas increase the number of objects toward which a person may react at any given time. With the development of thought, a person soon acquires a large

number of ways of reacting to the same object, amongst which he must learn to pick and choose.

The extent to which a rational being is subject to conflicts throughout life may be illustrated by the citation of numerous examples.

1. There are the temporal conflicts between remote and more immediate ends. Shall one buy an automobile or accumulate a competence for old age or a rainy day? Shall one gratify his palate or eat sparingly and wisely in the interest of future health?

2. There are the conflicts between individual and selfish aims on the one hand and social and altruistic objectives on the other. Shall the child gratify its own impulses or respect the rights and feelings of others? To what extent shall a boy assert his own independence or be dominated by his more masterful companions? To what extent shall one conform to social customs and conventions or act in accordance with his own beliefs and desires? Shall one live a life of pleasure or make certain sacrifices in order to aid the more unfortunate?

3. Somewhat similar are the conflicts between the so-called lower and the more ideal aspects of personality, — between living a life of gross sensuality or seeking to satisfy one's intellectual, spiritual, and æsthetic tendencies.

4. There are the problems of choice between future alternatives, — whether a girl shall choose a career in preference to marriage, whether the youth shall become a merchant or a lawyer, and whether the speculator shall go short or long on the market.

5. Conflicts are incidental to the normal development of every personality. Old beliefs, habits of thought, and attitudes toward the world must be continually discarded or reorganized as an incident of growth and a wider contact

with life. These developmental conflicts are peculiarly characteristic of adolescence and early maturity. Adolescence has been aptly termed the 'storm and stress' period of life. New interests and attitudes develop as a consequence of the emergence of the sexual tendencies. Shortly after comes the break with home ties, the cessation of parental control and domination, and the necessity for self-reliance and independence of thought and judgment. At the time of this development, the youthful individual frequently comes into contact with a social group whose beliefs and attitudes toward life differ radically from those of his home environment. Readjustments of this sort frequently constitute the most serious type of problem, and a failure to effect their satisfactory solution may spell moral and spiritual disaster.

6. Human nature is quite complex and it may exhibit many glaring inconsistencies between its several aspects. One's attitudes and principles of conduct in politics and business do not always square with his conduct in church, at home, and in his social circle. Every human being is to some extent a potential Dr. Jekyll and Mr. Hyde. Theory often conflicts with practice. Law and justice are not invariably synonymous. The high minded politician may find that his ideals fail to work and decide to sacrifice something to expediency in order to gain some legitimate end. The sincere philanthropist is often sorely embarrassed by the fact that his attempts at social amelioration do as much harm as good. There are also the conflicts between bodies of knowledge. One's notions concerning science, philosophy, and theology often exhibit many antagonistic logical implications. Neither is there complete consistency inside any special branch of knowledge such as chemistry or psychology. Many facts can not be subsumed under any known

theory, and assumptions and theories that nicely explain one series of phenomena may be inconsistent with the accepted mode of explaining another series of facts.

The adolescent youth is impatient and is usually desirous of an immediate and final settlement of all the problems of life, and as a consequence is inclined to pessimism when he begins to realize the hopelessness of the task. Too many problems require the cumulative efforts of a number of generations for their solution. Moreover, the attainment of a permanent condition of mental peace and contentment represents a false ideal of both individual and social development. A Utopian state of society will never be realized. Life is rather a process of growth and development and continuous readjustment, and new problems will continue to arise as fast as the old ones are solved or are outgrown.

The Solution. — The process of solving a problem may be characterized as a variable, persistent, and analytical ideational attack which is continued until the solution is more or less accidentally discovered. The first phase of the process consists of a preliminary analysis and definition of the problem which is conducted for the purpose of arousing an idea of some possible mode of attack. This idea is a product of past experience and it is suggested or aroused in virtue of its associative connection with some aspect of the problematical situation.

Such an idea, considered in its representative capacity, is termed an hypothesis, — a hypothetical or tentative plan of procedure, the feasibility of which is yet to be determined. The fundamental nature of an hypothesis is quite apparent for all concrete behavior problems such as the cane and fence situation.

The logical implications of the suggested hypothesis are

now subjected to analysis; the subject by means of thought attempts to discover the probable consequences of the proposed act, or attempts to make a judgment concerning its adaptive relation to the situation at hand. This process of analysis may be quite brief or rather long and exhaustive. The duration of the process will depend upon the complexity of the problem, the nature of the hypothesis and the mental habits of the individual. The analysis may be terminated in one of several ways:

1. It may be temporarily abandoned because of the arousal of a more attractive hypothesis. Naturally this consideration of the adaptive significance of the proposed act is conducive to a more adequate analysis of the nature of the problem, and this in turn is likely to suggest some other possible mode of procedure.

2. The situation may defy the analytical scrutiny of the individual, and the process be terminated because of the apparent hopelessness of the task. With a perceptual problem involving no serious consequences, the subject may now resort to the motor method in order to determine the feasibility of the contemplated mode of procedure, or to obtain some suggestive clue for a further rational attack.

3. The analysis may be continued until some decision as to the adaptive character of the act is attained.

These intellectual decisions concerning the adaptive significance of the contemplated mode of procedure are termed judgments and they may be either positive or negative in character, *i.e.*, the subject decides that the proposed act either is or is not adapted to the conditions of the problem. Unless a positive judgment is secured, the next step involves the arousal and consideration of a second hypothesis. The subject thus continues to analyze one hypothesis

after another until an affirmative judgment is attained, and this is termed a conclusion.

The validity of the conclusion must now be tested by an appeal to fact. With a perceptual problem, the subject at once responds to the situation on the basis of his intellectual decision, and naturally this overt response serves to test its validity. The conclusion represents the truth if the act is adapted to the situation, while it is false if the resultant mode of procedure fails to work. Ideational problems, however, represent prospective situations and hence their solutions can not be submitted to an immediate test. In so far as these prospective situations are subject to control, a person can proceed at his convenience to the arrangement of some experimental or test set of conditions. This is the usual order of procedure in the experimental sciences and the constructive types of industry. The chemist arranges certain laboratory conditions which are designed to test the truth of his rational conclusions. The inventor of a new machine first constructs a working model and subjects it to the test of practical conditions before engaging in its manufacture. In the event of a failure to verify a conclusion, the process of formulating and analyzing hypotheses must be continued until an affirmative judgment is attained whose validity withstands the test of its application.

An immediate and final test of a rational conclusion is not always possible. In so far as a solution refers to some prospective situation not subject to human control, any test of its validity must be postponed until that situation is encountered. The astronomer must await the coming eclipse in order to test his hypotheses. Perfect test conditions do not always occur and neither can they always be arranged, and hence a given conclusion may be only

partially confirmed or negated. Again the conditions may be such that several diverse hypotheses are equally applicable, and the test is not decisive. The problem may refer to past events such as the primitive origin of man or the age of the earth, and only very indirect and circumstantial types of evidence can be obtained in such cases. Likewise such questions as the habitation of the planet Mars are obviously not susceptible to a final settlement at present. A person may also speculate concerning conditions that lie outside the domain of human experience, such as the existence of spirits and the nature of the future life, and naturally one's beliefs concerning such matters can never be submitted to a crucial test.

Any belief or conclusion that has some rational basis but whose validity can not be subjected to an immediate final test is termed a ' theory.' Theories are not totally unrelated to fact. A theory develops from some problematical situation and it represents what its author believes to be the best and most feasible solution of the problem that is possible for the present. All science resorts to theory in so far as a final conclusion can not be obtained. Theories have their value. A tentative and provisional formulation of the factual data is usually better than none at all. Theories represent partial solutions of scientific problems and thus constitute a point of departure for further investigation. Theories naturally differ in their logical persuasiveness. Many theories are quite convincing in character and may be very widely accepted by careful scientific thinkers. All theories probably contain a certain amount of truth. The use of the term ' theory ' is always advisable, however, for it calls attention to the tentative and provisional character of the solution and to the need for its further verification.

Theoretically, the validity of a conclusion is to be judged solely in terms of its prospective application to a set of factual conditions. This doctrine, however, represents a scientific or logical *ideal* rather than a statement of fact, for a person's beliefs, even in the realm of science, are frequently determined in part by desire and prejudice. The personal equation can never be wholly eliminated from the rational process. In a consideration of such questions as the nature of the future life where no objective checks exist, a person's beliefs necessarily constitute an expression of his desires and habits of thought, and these in turn are a function of his personal reaction to his social heritage. Naturally, when no objective test or check is possible, a person is free to believe whatever he wishes. Much the same situation obtains for one's philosophical attitude toward the world. The type of thinking involved in a consideration of such topics is usually termed speculative, and any conclusion attained represents but little more than a personal opinion.

The personal equation is also a dominating factor in the realm of æsthetics, *e.g.*, in music, literature, and art. There are no objective criteria or standards of æsthetic values. What is good is a matter of personal taste. Each society, it is true, develops certain generally accepted norms, but these are merely an expression of the individual preferences that are common to the social group. Individuals differ quite radically in respect to their tastes in such matters, and a considerable diversity of opinion is the result. Questions of religion, politics, and social welfare offer a wide field for the play of the subjective factor, and it is a notorious fact that the attitude of most people toward such problems is determined very largely by their prejudices or personal interests in the matter. As previ-

ously noted, a conclusive and final test of a proposed solution is frequently impossible even in the domain of the physical sciences. The factual conditions are often ambiguous in their theoretical import; several proposed solutions may appear to be more or less equally rational, and a choice between these rival theories is often determined by purely personal considerations.

The influence of the personal factor in the determination of belief is not only necessary but entirely permissible in the absence of decisive data to the contrary and in so far as the subject is cognizant of the fact. Subjective conditions, however, frequently determine belief in spite of facts to the contrary; facts are distorted, ignored, or denied in order to satisfy some personal bias or interest. A person attempts to appraise the world of fact as he would like it to be rather than as it is. This tendency to conform facts to belief rather than belief to fact is wholly natural though logically indefensible. In the realm of overt behavior, a person reacts to an objective situation, not as an end in itself, but as a means of satisfying some appetite or desire. We drink water to alleviate thirst, and prepare and eat food to satisfy hunger. The same statement applies for the activities of thought. Satisfaction of personal needs, interests, and desires is the ultimate goal of all mental operations. This fact is implied in the very conception of the nature of adaptive activity.

Organisms do not invariably conform their acts to the world as given, but they also rearrange and reconstruct this world so far as possible in ways that will satisfy their needs. Man straightens rivers, builds bridges, drains swamps, and irrigates the desert. Why conform thought to external realities if one can satisfy his wants without so doing? Why should a woman appraise her husband's vices and

frailties in a wholly scientific and impersonal manner when she can attain marital peace and contentment by a distorted evaluation? An optimistic mental bias has its advantages as well as its limitations. Conformity of thought and action to objective conditions is but a means to the satisfaction of needs and desires and what is more natural than to ignore those conditions if satisfaction can be obtained in a more direct and economical fashion? One may assert with some degree of truth that the primal tendency of mind is to regard the world in ways that will please and that a person develops the habit of apprehending the world as it is through force of circumstances. The development of such habits of thought constitutes one of the main values of a scientific training.

Like the motor method, the rational search for a solution is somewhat random in character; the exact order of procedure can never be predicted in advance. A certain amount of chance is likewise involved in the discovery of the solution inasmuch as its nature and time of emergence can not be predicted or foreseen. Success may be achieved in the first or second trial or be attained only after a very long series of fruitless attempts. Often the clue to the solution of some baffling problem may come to us like a flash while our minds are preoccupied with other things.

In so far as the emergence of the successful hypothesis is a matter of chance, the likelihood of solving a problem is a function of the individual's persistence of attack. Persistence is a function of an individual's constitutional vigor, his ideals and the character of his mental habits. Individuals differ considerably in respect to their perseverance. Let us assume that each member of a class is possessed of the geometrical information requisite for the solution of an original problem that has been assigned to him. All

members of the class are capable of solving it if they do but persist in their attempts. Some individuals will give up after the first unsuccessful attempt, excusing themselves on the ground that they are lacking in mathematical ability. Others will try out several suggestions and then quit, while others will work until fatigued and keep returning to the problem with dogged zeal at every opportune occasion. Naturally those who are persistent are the most likely to effect a solution. Genius, with some degree of truth, has been defined as an unusual capacity for hard, persistent endeavor.

The likelihood of solving a problem is also a function of the versatility of attack. Some degree of variability is inherent in the rational process for the consideration of one hypothesis naturally involves a further analysis of the problem, and these new aspects in turn are likely to suggest some other mode of procedure. Individuals differ very materially in their ingenuity and resourcefulness of attack. Versatility is a matter of temperament and training. The greater is the wealth of knowledge brought to a problem, the greater the number of pertinent schemes for solution that are likely to be suggested. Some people have developed systematic methods of analyzing and apprehending problems in fresh and novel ways when the usual suggestions fail to work. Others exhibit resourcefulness in seeking suggestions from books of reference or from experts in various fields. The nature of the hypotheses suggested by a given problem is to some extent a function of the character of the preceding train of thought. Baffling problems are sometimes readily solved after an interval of rest, and this phenomenon is due in part to the fact that the problem is likely to be approached from a new intellectual standpoint. Some people have learned to take advantage of this

fact in promoting their versatility of attack when dealing with difficult problems. In the event of continued failure, they abandon the problem for the time being, occupy their minds in the meantime with other intellectual pursuits, and then return to its reconsideration with this new background of interests. It is sometimes alleged that a sense of humor and the spirit of intellectual play are aids to versatility. It is assumed that this habit of regarding things in unusual and droll ways for the sake of amusement will induce a more varied apprehension of the more serious problems of life. The importance of this mental trait can hardly be overestimated. It is the basic root of inventiveness and originality and it is usually regarded as one of the primal characteristics of genius.

The simplest type of rational process is that involved in the solution of a perceptual problem; it differs from the motor method primarily in the fact that ideas are employed as substitutes for the series of movements. This type of reasoning is often employed in conjunction with the motor method. Some of the acts are overtly executed, and some are ideationally represented. In a higher form of the rational process, ideas are employed as representatives of both the movements and the perceptual situation. The objective situation is either remembered or imagined rather than perceived, and the entire process of reasoning is carried on in terms of ideas. With the further development of rational ability, the various prospective behavior situations are conceived and solved in more and more general and abstract terms. The process of adjustment is now carried on primarily in terms of concepts. Finally comes the development of the highly abstract and speculative type of problem whose solution is effected without any thought of its

possible significance for the more practical aspects of human conduct.

Some authors limit the term reasoning to the solution of the abstract type of problem; reasoning and conceptual thinking are regarded by them as synonymous terms. This limitation of the term is hardly justifiable. Reasoning may be employed in the solution of concrete as well as of abstract problems. Neither is reasoning limited to the use of concepts in effecting a solution. Any sort of an idea, — memorial, imaginal, or conceptual, may be employed. The kind of idea that is used depends upon the character of the problem and the ever varying exigencies that arise in the course of its solution. The essential characteristic of a rational process is the fact that ideas are employed, and that as a consequence the subject is able to foresee the consequences of any suggested line of procedure, and that this anticipatory knowledge necessarily involves some understanding of the *reason why* any proposed solution is or is not adapted to the situation at hand.

The Process of Fixation. — It is sometimes assumed that reasoning differs from the motor method in that it does not involve this final process of selection and elimination by repeated trials. The assumption is erroneous. A very considerable amount of repetition is sometimes necessary in order to fixate the successful response. The successful act often requires some practice for its perfect execution. The thought of an act does not necessarily imply the ability to make that reaction. One can think of impossible motor feats as well as of difficult acts that can be readily performed only after some practice. One may think out a new dancing step or an improved swimming stroke, and yet these acts must be perfected by practice. Reason may

involve the discovery of a mode of reacting to a *prospective* situation, and this solution may be forgotten before that situation is actually encountered. To avoid this possibility, rational subjects are accustomed to write down the solution or devote some time to its memorization. For example, a student of geometry with much effort works out a solution for an ' original ' that has been assigned for the morrow's lesson, and then immediately repeats the various steps of the correct procedure until it is adequately memorized. The more cautious student may also write out the solution and review it from time to time in order to insure its ready reinstatement when called upon to recite.

Generalization. — In both the motor and rational methods, as has been frequently stated, a person solves problems by trying out modes of attack that have been of service in meeting similar situations. This transfer process obviously involves the rudiments of what in a more developed form is known as generalization. Since every solution has a prospective utility for other problems, a person, while effecting a given solution, may also attempt to formulate and state in a more or less explicit manner the range of prospective situations to which it may be applied. Such a formulation is known as a generalization and the process involved is termed generalizing. Generalization thus involves ideas and it is a rational operation.

Generalizations may be true or false, and it is often asserted that the similarity of two situations constitutes the basis for a correct generalization from the one to the other. The logical maxim that ' what is true for one situation is true for all similar situations ' is obviously incorrect, for any two situations are alike in some respects and different in others. Neither does a high degree of similarity guarantee the truth of a generalization. Two situations may

be highly similar and yet differ in some essential respect. Generalizations are valid only when the situations involved are alike in *certain respects*, and these essential points of resemblance must be discovered by empirical means. Two methods may be employed. The first is the method of practical application. The generalization is applied to all similar situations that are encountered, and is continually revised and reformulated on the basis of its success or failure in meeting these novel conditions. The common points of resemblance between the successful situations are discovered and are then utilized as the basis for further applications. The same process goes on in a non-reflective way with the motor method. A child is taught the name for a given object, applies this name to other objects, is corrected for its errors, and thus gradually attains a correct usage of the term (p. 100). The second method is one of experimental analysis. A given phenomenon occurs in the midst of some complex situation. The various components of this situation are experimentally varied one at a time in order to discover which ones condition the phenomenon in question. Let us suppose that three such factors are discovered. The experimenter then concludes that this phenomenon may be expected to appear in any other situation in which these factors are found.

The truth of a generalization may be considered from two aspects. On the one hand it sums up the results of the analytical process. It states what has been found to hold true for all those situations which have already been analyzed. Viewed from this standpoint, a generalization is true in proportion to the accuracy and completeness of this analysis. Generalizations also purport to state what may be expected to hold for a specified class of prospective situations. As predictive devices, generalizations never at-

tain any absolute certainty. They represent approximate or highly probable truths, and their degree of validity depends upon the number of cases upon which they are based and the accuracy with which these were analyzed. Application furnishes the only final test of the predictive truth of a generalization.

EXERCISES

1. Give several illustrations of thinking that would not be called reasoning.

2. Give an example from your experience of a reasoning process that involved all of the steps described in the text. If this is impossible, invent one.

3. Does much of your thought consist of incomplete processes of reasoning, — the fixation of solutions already discovered, the devising of hypotheses without testing their validity, the application of general conclusions to concrete situations, etc.? Elaborate and illustrate this suggestion.

4. Give several illustrations from your own experience of utilizing the motor method in the place of reasoning.

5. Give several illustrations in which the two methods have been combined.

6. Give several illustrations in which the problem was solved entirely by means of ideas.

7. Give a list of the essential points of resemblance of the two methods. State in what respects they differ.

8. Could an animal reason if it possessed ideas? Do you think that animals possess ideas? Does the fact that an organism acts so as to attain advantageous consequences imply that those acts were motivated by an idea of those results? See Chapter IV. Does a hungry babe cry in order to obtain food? Does the fact that animals influence each other's conduct by means of their vocal activities mean that these acts are performed because of a knowledge of their consequences? Do animals possess a language in the human sense of the term? Can you state the kind of behavior that necessarily implies the existence of ideas? Do you think that you can either prove or disprove the hypothesis that animals possess ideas?

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CHAPTER X

PRACTICE AND MEMORIZATION

Both reasoning and the motor method involve a process of selection and elimination, — the fixation of the successful response and the elimination of those that are unsuccessful. To a large extent this process of perfecting a solution is incidentally achieved in the course of our daily routine of activities. A child attempts to walk in order to move about among its world of objects, and the act of walking is gradually perfected as a consequence. A business man will learn the name of streets, buildings, and associates as well as various street and telephone numbers as an incident to the performance of his daily tasks.

The case is different when an individual attempts to anticipate and solve prospective problems, for a solution may be forgotten before a situation arises in which it will be of service. Solutions of prospective situations must be fixated by a process of repetition at the time of their discovery. Likewise, a solution may involve a motor response that needs some prior practice in order to ensure its perfect execution at the appointed time. An orator must not only prepare but memorize and rehearse his speech for the coming occasion, and the young man must practice the new steps before attending the dance. Fixation or drill work constitutes an important phase of all school work. Tables must be memorized and correct habits of speech be thoroughly inculcated.

The process of fixation thus emerges as a problem in any preparation for future contingencies. The intentional perfection and fixation of an act of skill by a series of repetitions in order to ensure its ready execution on some future occasion is known as *practice*. The purposeful repetition of material in order to ensure its ideational recall on a subsequent occasion is termed *memorizing*. These processes of practice and memorization are peculiarly susceptible to experimental study, and much work has been devoted to the discovery of the various conditions that favor or retard the fixation and retention of experiences. Some of the more important findings of these experiments will be recounted in this chapter.

Relative Efficiency of Successive Repetitions. — The first topic concerns the relative efficiency of successive trials in promoting fixation. Does the greater progress occur in the initial or the final trials? This question may be answered by measuring the amount of progress attained at various stages in the process of fixation. A person is required to practice typewriting for thirty minutes daily, and at the end of each week he is given a five minute test to measure his speed and accuracy. In this way we can ascertain the amount of progress made during each week of practice, and thus directly compare these units of practice in respect to their relative efficiency in promoting progress. Similar data may be obtained for memorizing a list of words. The subject is required to read through a list of words at a given rate, and a record is then obtained of the number of words which he is able to recall. This procedure of alternate reading and testing is continued until the subject is able to repeat the entire list from memory, and the number of words memorized during each reading will indicate their relative efficiency.

The relation of the series of values indicative of progressive attainment to the number of repetitions or practice periods is usually represented by means of a graph which is known as a learning curve. Three such graphs are given in Figure 38. The values along the horizontal line represent the increasing number of repetitions or practice periods, while the variable height of the graph above the base line

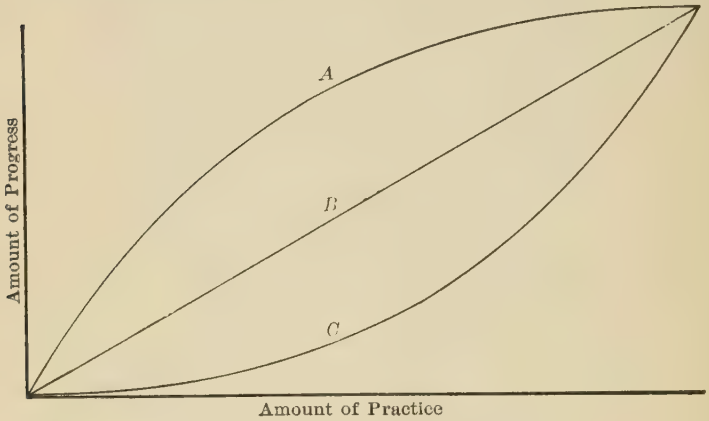

Fig. 38 — Three types of learning curves.

indicates the progress attained after each amount of practice. The form or shape of the graph thus represents the relative efficacy of the successive practice periods in promoting progress. According to Curve *A*, the effectiveness of the successive trials decreases in a regular manner throughout the total period of practice. The greatest amount of progress is made during the initial trials and the least amount during the final ones. The reverse relation is represented by Curve *C*. The least progress is made during the initial trial, while the succeeding practice periods become more and more effective. Curves *A* and *C* are said to ex-

hibit negative and positive acceleration respectively. According to Graph *B*, all practice periods are equally effective. The subject learns as much in one trial as in another.

Progress may be measured in terms of either accuracy, speed, or amount of material learned, and the method employed will vary with the problem. Progress in typewriting can be measured in terms of both accuracy and speed. The same two methods are also applicable to the maze problem, progress being measured in terms of the decreasing time or error values. Speed is the only criterion that can be employed in the latch box type of problem described in Chapter V, while progress in archery for example can be measured only in terms of accuracy. Progress in memorizing on the other hand can be measured only in terms of the amount of material that can be recalled.

Curves will either rise or fall according to the method of measuring progress that is employed. The speed of typewriting may be measured either in terms of the number of words written per minute or in terms of the amount of time required to type a hundred words. In the first case progress will be indicated by an increasing series of values, and by a decreasing series in the second case. In other words, an ascending curve will be obtained with the use of one method, and a descending curve with the other. Likewise the accuracy of typewriting can be measured in terms of the number of errors made or in terms of the number of words correctly written; the curve will rise in the one case and fall in the other. Progress in memorizing will always be represented by an ascending curve, while descending curves will be obtained for the maze and latch box problems. The ascending or descending character of a curve is of no particular importance however. It is the shape or form of the curve that is significant.

Learning curves have been secured for a wide variety of conditions, — for the memorization of all sorts of material, and for the acquisition of various acts of skill by both human and animal subjects. No particular form of curve is invariably secured. The relative efficiency of the trials thus varies with conditions. Curve *A* is the form that is most frequently obtained for both animal and human subjects, and in this sense it may be regarded as the typical learning curve (see Figures 39 and 40). Graphs like those of *B* and *C* are also obtained. All curves exhibit a certain amount of irregular fluctuation from trial to trial however. Learning curves merely approximate the types of graph represented in Figure 38. In addition the most rapid rise may sometimes occur during the middle portion of the graph. Again, no apparent progress may be made for a considerable number of trials, and corresponding to this period the graph will run parallel to the base line. Because of the flat appearance of the graph, this phenomenon is known as a plateau, — a period in which the practice is apparently without effect in achieving progress. This plateau phenomenon occurs but rarely, however.

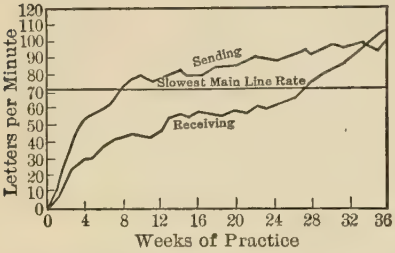

Fig. 39 — Graphical representation of improvement in learning telegraphy (Bryan and Harter).

The relative efficiency of the trials varies with a number of conditions.

1. The form of the curve varies with the nature of the problem. Plateaus are found only in complex problems that require a long period of practice for their mastery.

Curve *C* is invariably secured in a certain animal problem in which the animal is confronted with two possible routes to the food box. After making a choice, the animal is required to master the habit of turning around and taking the other path whenever a signal is sounded but to continue going forward when no stimulus is given.

2. The form of the curve varies with the individual. Some individuals are susceptible to the plateau phenomenon

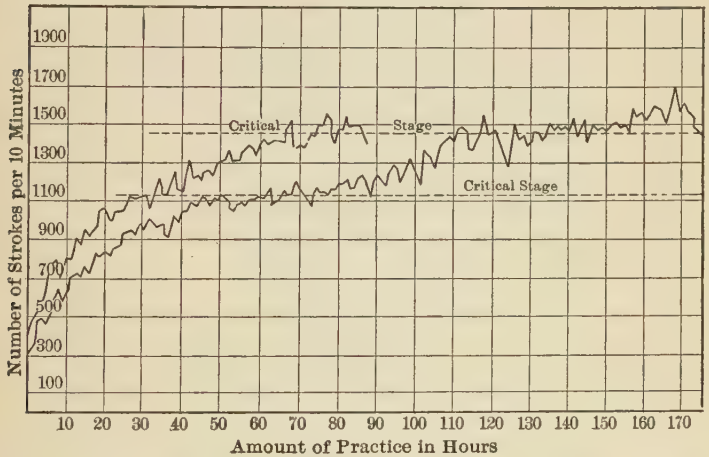

Fig. 40 — Graphical representation of progress in learning to typewrite by the sight method (Book).

and others are not. The weekly progress of a class of high school students in mastering the technique of typewriting has been studied. The majority of the curves conformed to type *A*, while the *C* type of curve was obtained in a few cases.

3. The shape of the curve varies with the method of measuring progress. When progress in typewriting is measured in terms of speed and accuracy, the shape of the two curves will differ to some extent. The time and error curves

representing the mastery of the maze problem never exhibit exactly the same shape. An individual's progress in typewriting may be measured either in terms of the number of words written per minute or in terms of the average time involved in typing a single word. In the first case, progress will be indicated by a series of values such as 10, 20, 30, 40, and 50 words per minute. When the average time per word is computed from these records, a series of values will be secured ranging from one-tenth to one-fiftieth of a minute. In other words, the two series of values will be reciprocals of each other, and any two such series of values will necessarily give differently shaped graphs.

4. The form of the curve also varies with the unit of practice employed. The amount of practice may be measured in terms of units of time or units of work performed. For example, a subject may be tested for his progress in typewriting after each hour of practice or after typing twenty pages of material.

An experimenter has studied the effects of practice in tossing and catching two balls with one hand. Each day's practice was terminated after ten failures to catch a ball, and the subject's daily progress was measured in terms of the number of successful throws per day. Naturally a learning curve like that of *C* was obtained for the amount of practice secured each day kept increasing with improvement. If these results had been stated in terms of the number of successful throws made in each successive one thousand attempts, a curve like that of A would have been obtained. The animal's progress in mastering the latch box problem is represented by the time involved in effecting an entrance for each successive trial, and the *A* type of curve is usually obtained. Since these time values keep decreasing from trial to trial, it is only natural to

expect that the initial or *longest* trials will be the most effective. The animal should learn more in a trial requiring thirty minutes than in one of thirty seconds duration. In other words, the form of curve is to some extent due to the fact that the length of the trials keeps decreasing with progress.

Certain theoretical suggestions have been advanced to explain the form of the learning curve. The influence of fatigue has been suggested as an explanation of the *A* type of curve. It is assumed that the efficiency of the successive trials will keep decreasing as the subject becomes more and more fatigued with his continuous efforts. This form of curve can be obtained, however, when the conditions are so arranged as to eliminate the possible influence of this factor. Fatigue can hardly be regarded as a factor in a simple type of problem that can be mastered in a few trials as in the case of memorizing a short list of words. Moreover, this type of curve can be obtained when but one trial per day is given. Fluctuation of interest is a possible factor. Even with the most rigid experimental conditions, it is impossible for a subject to maintain the same level of interest throughout a large number of trials. It has been suggested that the highly irregular character of the curve is due to these fluctuations of interest from trial to trial. Plateaus are sometimes regarded as due to a temporary slump of interest. The lesser effectiveness of the final trials in the *A* type of curve is supposed to be due to the loss of interest incident to continuous effort. The concept of 'physiological limits' has been suggested to account for the *A* type of curve. The speed with which any act can be performed can not be indefinitely improved with practice. The possibilities of speed are obviously limited by organic conditions. It has been suggested that the graph of im-

provement for any task that involves a physiological limit must necessarily assume a form like Curve *A*, inasmuch as progress will become more and more difficult as this limit is approached. A similar conception has been suggested for the process of memorizing. The various words of a list are not always equally difficult to memorize. The easy words will be mastered first and the more difficult ones will be reserved for the later trials, and as a consequence the initial trials will be the more effective so far as number of words learned is concerned.

The Temporal Distribution of Trials. — The various trials involved in fixating an act may be given in immediate succession, or certain intervals of rest may be permitted from time to time. The trials are said to be ' massed ' in the one case and ' temporally distributed ' in the other. It has been found that the number of trials required for fixation is a function of their temporal distribution, and many experiments have been conducted in order to discover the best or most advantageous type of distribution.

It is at once obvious that all sorts of distribution are possible:

1. The length of the interval may be kept constant, and the frequency with which it is inserted be varied. For example, an hour of rest may be permitted after each trial or after each third, fifth, or seventh trial.

2. Likewise, the frequency may be kept constant and the length of the interval varied. Intervals of a minute, an hour, a day, a week, a month, or a year may be regularly inserted after each trial.

3. The efficacy of any rest period may vary with the stage of learning at which it is inserted, and consequently the most advantageous results may be secured if both the length of the interval and the frequency with which

it is inserted are altered during the course of learning. For example, relatively short intervals may be employed at one stage of learning and long intervals at another. The intervals may be frequently inserted during the initial trials and be infrequently employed during the final stages of mastery.

When the frequency of insertion is kept constant, the number of trials required for fixation varies with the *length* of the interval. With a thirty minute practice period on a substitution problem, one experimenter found that a one day interval was better than a twelve hour or a two day interval. Another experimenter found that the best interval to employ in memorizing nonsense syllables is a function of the frequency with which it is inserted. When the intervals were inserted after each trial or after every other trial, a period of two days was better than either a one, three, or four day interval. When the rest periods were inserted after every fourth or eighth trial, however, the four day interval was the best. In other words, the more frequently the interval is inserted the shorter it must be in order to obtain the best results. No such relation between length of interval and frequency of insertion was obtained with the use of animals on a maze problem. Intervals of six hours, twelve hours, one day, three days, and five days were employed, and each of these intervals was inserted after each trial, after every third trial, and after every fifth trial. Without exception the problem was mastered with the least number of trials when the twelve hour period was employed. When this experiment was repeated with the use of human subjects on a stylus maze, it was found that a four day period was better than any smaller interval when the intervals of rest were inserted after each trial, but that the various intervals did not differ

in effectiveness when they were inserted after every third trial. On the basis of these and similar results, we may conclude that the number of trials required for fixation at first decreases and then increases as the interval of rest is lengthened. Short intervals are usually beneficial and very long intervals are detrimental as compared with massed trials. The optimal interval, — that which is conducive to the most rapid rate of learning, evidently varies with a number of conditions such as the nature of the problem, the type of subject, and the frequency with which the interval of rest is introduced.

When a beneficial interval is employed, the more frequently it is inserted during the process of learning, the fewer will be the number of trials required. For example, a problem can be mastered more readily when the interval of rest is introduced after each trial than when it is introduced after every third, fifth, or seventh trial. This conclusion is based upon the results of a large number of experiments in which both animal and human subjects were employed. No significant exception to the rule has as yet been discovered.

Several experiments have indicated that the value of a rest period varies with the stage of learning at which it is inserted. With the use of the stylus maze problem, one experimenter found that a two day interval was most effective when it was introduced after the seventh trial, while a one day interval was conducive to the most rapid rate of learning when it was inserted during the initial trials. These results indicate that short intervals should be employed in the early stages of learning and longer intervals in the later ones in order to obtain the most effective distribution of practice. Sufficient data, however, are lacking at present to justify any general statement.

The detrimental influence of the very long intervals can be accounted for by the fact that the effects of practice tend to disappear with the passage of time. The beneficial influence of the shorter intervals is not so easily explained. It has been suggested that the intervals are valuable because they prevent fatigue or permit the subject to recuperate from its effects. This conception is feasible when the task is quite long and but few intervals are permitted; it fails to account, however, for the advantageous effect of the frequent insertion of a twenty-four hour interval in such a short task as memorizing a list of twenty words. The intervals may be valuable for the purpose of review, but it has been found that their value still obtains when the subject is otherwise occupied during this period of time. It is generally conceded that the process of fixating an act occurs not only while the act is being exercised, but that it continues on an unconscious level for some time after practice has ceased. In the words of William James, a person learns to skate in summer and swim in winter. Since the process of fixation continues on an unconscious level during the intervals between practice, it is evident that the best results will be obtained if each trial is delayed until the full effect of the previous trial has been realized. Any speculation concerning the nature of this unconscious process is futile for the present.

Length of Material. — Is the time required to memorize a list of twenty words twice as long as the time required to learn a list of ten words? Is the time involved in memorizing a list of words proportional to its length, or is short material easier or harder to learn than long material? Practically without exception it has been found that material becomes proportionally more difficult to master as its length is increased. One subject required thirteen and sixty-

five minutes to memorize lists of twelve and thirty-six pairs of syllables respectively. With another subject the time values were seven and thirty-four minutes. The list that was three times as long required five times as much time for its memorization. The average time involved in memorizing a pair of syllables of the short list was only sixty per cent of that required for a pair of the longer list. The shorter the material, the easier it is to memorize even when allowance is made for differences in length.

In any material, some parts are memorized more quickly than others. The parts that are adequately memorized in the early trials are thus needlessly repeated in the later trials. It is obvious that the shorter the material, the less will be the amount of this useless repetition, and this fact will account in part for the relation between length and ease of learning.

Whole and Part Methods. — Poetry may be memorized stanza by stanza and then these separate units can be connected by reading the poem as a whole. This procedure is known as the part method. With the whole method, the subject reads through the poem from beginning to end and keeps repeating this procedure until it is completely memorized. Much experimental work has been devoted to the task of discovering the relative value of these two methods.

In the majority of cases material can be memorized in less time when the whole method is employed. This rule obtains when the kind of material and its length are varied, and when the trials are massed or distributed. There is some indication that the part method becomes relatively more and more detrimental as the number of parts into which any material is subdivided is increased. Some results indicate that the relative value of the two methods varies

with individuals and that the superiority of the whole method is limited to practised subjects. The whole method proved to be the superior one for mastering a maze problem with distributed trials. Both human and animal subjects were employed in this experiment. When human subjects mastered this same problem with a continuous series of trials, it was the part method that proved to be the superior. Evidently the relative value of the two methods will vary somewhat with conditions, and any general statement of their efficiency must be viewed with some degree of suspicion.

In all probability each method has its good and bad features. The part method is certainly economical in that it subdivides the material into short and hence relatively easier units. As developed in the previous section, the four stanzas of a poem can be memorized as separate units in less time than the poem can be learned as a whole. The part method, on the other hand, is at a disadvantage because of the formation of place associations. During the successive repetitions of a stanza, its final sentence will necessarily become associated with its initial sentence rather than with the beginning of the subsequent stanza. Because of this fact a subject will generally break down at the point of transition from part to part when attempting to recite material which has been memorized in this manner, for naturally the end of each part will suggest its beginning rather than the initial portion of the next unit. The process of establishing an association between the series of parts will thus require an extra amount of time because of the necessity of breaking up these place associations.

According to this conception, any combination of the two methods that eliminates their detrimental features will be more efficient than either of them. As a matter of fact

several such combination methods have been discovered. The most efficient method of mastering a maze problem is to learn the various sections as separate units but to unite each section with the previous ones as soon as it is mastered.

Rhythmical Presentation. — There is a natural tendency to rhythmize material while it is being memorized. Note the singsong character of children's recitations. All materials are susceptible to some degree of rhythmization, and the ease of memorizing any material is proportional to the degree to which it is rhythmized. A very considerable saving of time can be effected in this manner. The best rhythm to be employed varies with the subject and the character of the material.

It may be suggested that the rhythmical organization of material is beneficial because it constitutes an effective combination of the whole and part methods. On the one hand, the material is subdivided into short and relatively easy units, and yet no place associations are formed because the material is studied as a whole.

Sensory Mode of Presentation. — In memorizing, the list of words may be presented to the eye or ear, or to both senses simultaneously, and the words may or may not be articulated at the time of their presentation. Much experimental work has been performed to determine the relative value of these various modes of presentation.

No consistent results have been obtained. Some experimenters have found that articulation is an aid with the majority of subjects, while the opposite result has been obtained in other experiments. Some have found that visual presentation is better than auditory for most subjects, while auditory presentation is the more efficient in other experiments. Sometimes the material may be memorized

more readily when it is presented to the eye and ear simultaneously, and sometimes better results are obtained when but one sense organ is employed. Evidently the relative values of the several modes of presentation vary with the individual, and probably with other conditions as well.

The individual factor is probably due in large part to differences in training and habits of study. A person who is accustomed to articulate words while memorizing them will naturally be at a disadvantage when requested to inhibit this tendency, while a person who does not articulate will be distracted by the attempt to do so. A college student who organizes and memorizes the materials of a lecture while listening to it will naturally be able to memorize better with auditory than with visual presentation, while those students who are accustomed to the textbook method of instruction will do better with vision. It is thus obvious that any statement concerning the relative value of any two modes of presentation is worthless unless the subjects employed in the experiment are equally practiced in memorizing material in these two ways.

Volitional Attitude. — A subject may assume a relatively active or passive attitude while memorizing. Materials are learned much more readily when an active attitude is adopted. One experimenter found that his subjects, during a short exposure, memorized thirty-nine and twelve per cent of the material for the active and passive attitudes respectively. When a series of pairs of words were presented and the subject was informed that he would be expected to recall the second member of each pair upon the presentation of the first, a score of seventy-four per cent was obtained after three exposures of the material. When a similar list of pairs was thrice presented and in the subsequent test for recall the subject was asked to

recall the first member of each pair upon the presentation of the second member of the preceding pair, only seven per cent of the material was reproduced.

Individuals differ very materially in the type of attitude which they normally assume. Some students read over their lessons with a passive attitude, while the good student actively analyzes and organizes the material as it is read. In the lecture room, the passive student seems to regard it as the business of the instructor to impart the material in such a way as to make it stick, while the alert and active student attempts to organize and assimilate the material on his own initiative. By employing additional incentives, it is possible for a teacher to induce a student to assume a more active attitude than usual and thus to increase his rate of learning.

Logical vs. Verbatim Memorizing. — There are two methods by which material can be memorized, the rote or verbatim and the rational or logical. In the verbatim method, the various items are *directly* associated with each other. To be proficient in this method, a person must cultivate the habit of reading over the material rather rapidly and repeating it quite frequently, for the ability to recall depends upon the strength of the few associations that are established. *Indirect* associations are employed in the logical method. Words are associated in terms of their interrelated meanings, *i.e.,* they are associated with various items of previous experience between which associations have already been established. A slower rate of reading is thus required in order to give the subject time to exhaust the various possibilities of logical connection. Any proficiency in this method naturally presupposes some degree of mental ingenuity and alertness. Less repetition of the material is required, for recall is dependent upon the num-

ber of the associations established rather than upon their strength.

The two methods thus involve somewhat different mental attitudes, and most people have developed the unfortunate habit of employing one method to the exclusion of the other. Contrary to popular opinion, both methods are valuable and both should be cultivated. The verbatim method is adapted to the disconnected type of material such as a list of telephone numbers. Materials of this sort are frequently encountered in practical life, and persons who have become addicted to the exclusive use of the logical method naturally experience some difficulty in memorizing this kind of matter. Meaningful material can be more readily memorized with the logical method, provided the subject is somewhat accustomed to its use. The reasons are obvious. The method utilizes associative connections that have already been partly established and hence but few additional repetitions are necessary, and, the more numerous the associations involved, the less is the degree of strength that is essential for recall.

Individual Differences. — Individuals of approximately the same age and training differ quite radically in their mnemonic ability. A group of twelve college students were required to memorize forty lists of nonsense syllables, and the most rapid memorizer learned this material in nearly one-half of the time required by the poorest individual of the group. In another group of ten students, each of whom mastered at least twenty such lists, the best record was three times as good as the poorest one. In any small group it is thus possible to find one person who can memorize material two to three times as readily as the poorest member of the group. When such homogeneous groups are divided on the basis of their mnemonic ability into two

sections, the average ability of the superior section will be at least fifty per cent greater than that of the poorer one. These individual differences are to a considerable extent independent of the kind of material memorized, for an individual who makes a high score for memorizing prose will usually make a fairly good record for memorizing poetry and lists of numbers and syllables. The experimental data do not permit of any very definite statements as to the range of individual ability in mastering acts of skill. In a recent study, ninety students were required to master a series of five stylus mazes. When these subjects were divided into two groups on the basis of their records in one maze, it was found that the poorer group took nearly twice as many trials to learn the series of mazes as were required by the superior group.

The Influence of Age. — For the most part the ability to learn gradually increases with age up to maturity and thereafter remains relatively constant until rather late in life. So far as memorizing ability is concerned, this law has been thoroughly established by extensive experimentation. The law holds for memorizing all sorts of material from lists of disconnected items such as a series of nonsense syllables to passages of prose and poetry. When we come to the acquisition of acts of skill, the law must be accepted with a considerable degree of caution. It has been demonstrated that adults can master a maze problem more readily than children, and the law has also been verified for another simple act of skill. Too little experimental work has been done in this field, however, to permit of any confident generalization, and further tests may reveal the fact that some motor accomplishments are more easily acquired by children. In fact, one experiment has indicated that young

animals can learn the maze problem as readily as can older animals.

This improvement of ability with age may be due to the maturation of the organism or to the accumulating effects of training. Naturally the influence of the two factors can never be separated. It is possible to isolate to some extent the effects of scholastic training as distinct from the combined influence of age and the training received outside of school, and in so far as this has been accomplished, the results indicate that the former is by far the more effective factor in mnemonic ability.

These experimental findings contradict many popular notions. Adults are apt to assume that their rote memory ability has deteriorated since youth. This belief is totally unwarranted. The assertion is also made that youth is the best time in which to learn to skate, swim, and dance, and to acquire the ability to speak a foreign language. Adults do experience some difficulty in mastering many of these activities, but this fact is not necessarily due to a deterioration of ability. Their slow progress in many cases is due to a lack of interest. Youth takes such accomplishments much more seriously than do older people. Adults are also dominated by many inhibiting motives. They are sorely embarrassed by their mistakes and initial awkwardness, and fear the ridicule of their companions. Adults appear at a disadvantage simply because they are unwilling to throw themselves into these pursuits with the utter abandon and whole-hearted enthusiasm of youth. They can learn as readily as children but fail to do so because they do not try.

Influence of Tuition. — Any attempt on the part of the experimenter to aid the subject during the process of fixa-

tion may be called an act of tuition. In view of the extent to which various methods of tuition are employed in schools, this topic has not received the attention its importance merits.

The most systematic experiments on the influence of tuition have employed the stylus maze problem. It has been found that any information given to the subject concerning his mistakes will aid in their elimination. This information is the most effective when it is given during the initial trials. Knowledge of an error is not essential to its correction, however, for it has been found that errors may be made and eliminated without the subject being cognizant of the fact. The speed of learning may also be influenced by preventing the subject from making mistakes. Errors may be prevented by a series of verbal instructions or by guiding the stylus over the correct pathway by hand. Both forms of guidance have proven effective. The most beneficial results are obtained when the guidance is introduced for a limited number of trials during the early part of the learning process. The number of trials required to learn the maze problem may be reduced by one-half when the proper amount and distribution of guidance is given. Detrimental results are also obtained when too much guidance is given or when it is introduced during the final stages of mastery. The number of trials required to master the problem may be doubled by such means.

The detrimental effect of too much guidance establishes a very important principle of learning. A certain amount of error is essential to the perfection of an act of skill, for the act will never be mastered when all possibility of error is prevented. It is thus necessary to make and eliminate a certain number of mistakes in order to learn how to execute

the act properly. The process of error elimination can not be wholly explained in terms of the gradual strengthening of the correct response in virtue of its repetition; the establishment of the correct act is also due in part to the elimination of the errors. We learn through the correction of our mistakes. The right act is established in part by learning what not to do. The right act is fixated not only by repeating it but also by making mistakes and correcting them.

Transfer of Training. — The ability to perform any act is due to the accumulated effects of the various trials involved in its mastery. These accumulated effects also persist and may influence the ability to acquire some other act. This process of utilizing the effects of previous experiences in acquiring some new act is known as transfer of training.

The ability to learn may be very materially improved by previous training. When college students are required to learn a list of nonsense syllables each day for a period of fifty days, their ability to memorize this type of material may be more than doubled. Moreover, the major portion of this increased efficiency will be due to the training secured in memorizing the first ten lists. The training secured in memorizing this nonsense material will also improve their ability for memorizing other types of material but not to the same extent. In general, the more similar the material, the greater will be the transfer effect. The mastery of one maze will double one's ability to learn a similar maze. The training secured in performing an act with the left hand will very materially increase the ability to learn this act with the right hand and vice versa. The training secured in adding various lists of numbers will increase one's proficiency to add other lists of numbers. The training involved

in learning to walk will be found to be very essential to the process of learning to skate and dance.

The transfer effect may also be detrimental. The mastery of a stanza of poetry may interfere with the ability to memorize these same words when arranged in a nonsensical order. The training involved in sorting a deck of cards and arranging the suits in a given spatial order will interfere with the ability to arrange them in some other order. When an animal is confronted with two diverging paths, and is taught to choose the left path when a bell is sounded and the right path when no sound is given, this training will exert a very detrimental effect upon his ability to acquire the habit of turning to the right in response to the sound and to the left in response to silence.

Transfer does not invariably occur between any pair of activities. Training in memorizing will be no aid in learning to swim, and learning to swim will not affect one's ability to memorize or one's skill in typewriting.

The above fact has induced many people to minimize the importance of transfer in mental life. As we have emphasized throughout the text, all learning involves transfer. Every new act is learned in terms of previous acquisitions. The dog solves the cane and fence problem in terms of his previous modes of dealing with similar situations. Some of the transferred activities are valuable in enabling the animal to solve the new situation, while the influence of others is distinctly detrimental. Learning to dance is obviously dependent upon the previous training obtained in learning to walk and run. The ability to memorize a list of words is not only dependent upon previous practice in memorizing but also upon the previous acquisition of language. In order to acquire the art of typewriting, a person must first learn to read and spell, be able to sit erect in a chair, and acquire

some facility to move the fingers independently of each other. Reasoning is a process of solving problems in terms of knowledge previously acquired. Transfer is involved in the formation of general principles and in their application to concrete behavior situations. In fact, transfer constitutes one of the essential features of every mental act.

Many attempts have been made to formulate the exact conditions under which transfer does and does not take place. No very accurate statements can yet be made. In a very general way it may be said that transfer will occur only between two rather similar situations. Any very complex activity will be more affected by transfer than will some very simple process. In all cases transfer exerts some detrimental as well as a beneficial influence upon the acquisition of the new activity, but for the most part the advantageous effect is the greater. Under certain conditions, the detrimental aspects may predominate and the process of transfer will retard rather than accelerate the process of learning.

EXERCISES

1. A person was given a ten minute test after each month of practice in typewriting. The number of words written in these successive tests were 100, 240, 400, 520, 600, and 670. Construct two learning curves, using in one case the average number of words written per minute, and in the other the average number of seconds required to write a word. In what respects do the two curves differ? Which gives the more valid representation of the individual's progress?

2. In what terms was the amount of practice measured in the above example? What other criteria could have been used as a measure of the amount of practice? What other means could have been employed in measuring progress?

3. In preparing to take an examination, should you review the materials from time to time or cram during the day previous?

Is a certain amount of cramming permissible if you have studied regularly throughout the course?

4. Do you rely mainly upon the logical or the rote method of memorizing? Have you noted any difficulty in using this method with certain materials? In mastering the contents of this chapter, what parts should be memorized by the rote method and what parts by the logical method?

5. Can you learn most readily from a book or from a lecture? What are the relative advantages of each method?

6. Why can poetry usually be learned more readily than prose? To what extent will the ease of memorizing two prose passages of equal length and expressing the same ideas depend upon differences of sentence structure? Why?

7. Can a person learn to play golf, or swim, or dance by the exclusive use of the method of verbal instruction, or is a certain amount of practice essential? Is too much verbal instruction merely useless or detrimental?

8. In the cultivation of moral character, should a child be protected from all knowledge of and contact with evil, should he be allowed to 'sow his wild oats,' or should neither extreme be adopted? Justify your answer.

9. How would you utilize the information of this chapter in memorizing a table of historical dates, a poem, the demonstration of a geometrical proposition, and in mastering an act of skill like typewriting?

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CHAPTER XI

RETENTION AND RECALL

A given experience is said to be *retained* in so far as it is capable of being revived or reinstated on a subsequent occasion. The process of reviving a previous experience is termed *recall,* while the loss of the ability to recall is termed a process of *forgetting.* Much experimental work has been performed for the purpose of discovering the various conditions that influence the ability to retain and recall that which has previously been learned.

The Temporal Rate of Forgetting. — As is well known, the ability to recall material decreases with the passage of time. The details of this relation, however, must be discovered by experimental means. In the pioneer study of memory, Ebbinghaus found that lists of nonsense syllables were forgotten most rapidly immediately after they were memorized and that thereafter the rate of forgetting gradually diminished. This relation between retention and the passage of time is graphically represented by the curve of Figure 41. The various values along the base line represent the increasing intervals of time for which retention was tested. The height of the curve above the base line represents the percentage of the material which was retained for the various intervals, while its distance from the upper line is a measure of the amount forgotten. The process of forgetting proceeds very much more rapidly at first than later. Approximately two-thirds of the material

is lost during the first three days, while thereafter the rate of deterioration is quite slow.

The fact that the rate of forgetting diminishes with time has been verified by many other experimenters in so far as they have used adult subjects and memory materials. The form of the Ebbinghaus curve does not represent a universal law of retention, as is sometimes assumed, for dif-

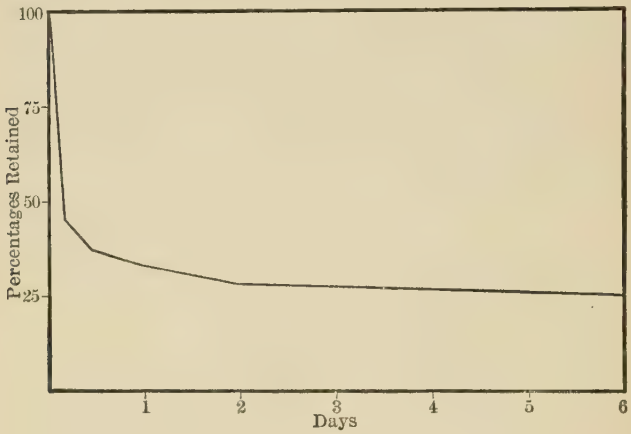

Fig. 41 — The Ebbinghaus curve of retention.

ferent results have been obtained with other conditions. One experimenter found that the ability of school children to recall partially memorized material actually improved during the first two or three days and then gradually declined. These children were able to recall almost as much of the material at the end of a week as immediately after its presentation. These facts have since been verified in the main by two other experimenters. The peculiar nature of these results is apparently a function of the age of the subjects, though it is entirely possible that the opportunities for review were not adequately excluded. Some-

what similar results have been obtained in studying the retention of acts of skill. It was found that the loss of efficiency in typewriting was but five per cent after a period of four and a half months, whereas, when tested a year later, the subjects had recovered this loss and exhibited a proficiency five per cent greater than that attained at the end of the practice period. An increase in proficiency after a year's period of no practice was also demonstrated in the ball tossing experiment. The retentive ability of animals has also been studied for two different problems. A gradual loss of proficiency was exhibited throughout a period of twelve weeks. Approximately straight line graphs were secured in all cases. In other words, the rate of forgetting was practically uniform throughout this period.

Individual Differences. — Individuals differ considerably in their retentive capacity. Among individuals of the same age and training, those who learn most easily usually have the best retentive capacity except when retention is measured by the 'relearning method' (p. 247). It has been found that children retain better than adults although they do not learn as readily. In fact, it has been suggested that children retain a greater amount of the material they learn because of the greater effort required to master it. Retentive ability is also supposed to deteriorate with the onset of senility.

Character of the Material. — Some materials are more readily retained than others. The longer and more difficult the material, the better it is retained. For example, a list of twenty words will be retained more effectively than will a similar list of ten words. Probably this fact is due to the greater effort required to memorize the twenty word list. Meaningful material is usually more easily remem-

bered than is a list of disconnected items at least when retention is measured by the relearning method. Acts of skill are retained much more effectively than is memory material. For example, a group of subjects exhibited a proficiency of seventy-six per cent for the stylus maze problem after an interval of two weeks, while another group of subjects was able to retain but fifty-one per cent of a list of nonsense syllables after a similar interval of time.

Retention and the Methods of Learning. — Materials learned by the whole method are better retained as a general rule than those that are learned by the part method. A beneficial distribution of trials during learning is usually conducive to a high degree of retention. Materials learned by the logical method are supposed to be retained more effectively than those mastered by the rote method. Retention also varies with the degree of learning. As a general rule, the more frequently the material is repeated, *i.e.*, the more thoroughly it is mastered, the greater will be the degree of retention. The amount retained, for a period of three or four days at least, does not increase proportionally with the number of trials. After the material is once memorized so that the subject is able to recall it, any additional repetitions are relatively valueless and sometimes may be even detrimental. For example, in a recent experiment a list of items was memorized until the subjects were just able to recall it correctly. With a second list of items the subjects were given a number of additional repetitions after they had memorized it to the point where they were able to recall it. When tested one day later, the subjects were able to reproduce but thirty-nine per cent of the second list as compared with forty-six per cent for the first list. The rate at which partially learned

material is forgotten is somewhat more rapid than is the case when the material is completely memorized. Materials should thus be thoroughly memorized in order that they may be retained with any degree of effectiveness for a considerable period of time.

The Influence of Subsequent Activities. — The ability to recall any material depends to some extent upon what one does in the interval between its acquisition and the time of recall. These interpolated activities may exert either a beneficial or a detrimental effect. The deterioration of an act of skill can be readily prevented with but little practice. In the ball tossing experiment, the proficiency of the subjects was maintained by one short practice period per month. Memorized materials can also be kept in mind for considerable periods of time by occasional rehearsals.

On the other hand it has been experimentally demonstrated that the recall of one activity will be impaired by the subsequent acquisition of a similar activity. This phenomenon has been termed ' retroactive inhibition.' The ability to traverse a maze that has once been learned will be slightly impaired by the subsequent mastery of another maze. The ability to recall a memorized list of words will be detrimentally affected if similar materials are memorized in the interim. Memorizing a list of numbers will interfere with the successful recall of a similar list which has previously been learned. Memorizing words, however, will hardly affect the recall of number material, nor vice versa. Neither will the ability to recall a list of numbers be greatly affected by the subsequent performance of such numerical operations as addition and subtraction.

Everyday life furnishes many illustrations of the phenomenon of retroactive inhibition. Under the usual

conditions of life, adults can recall but a limited portion of the experiences of their youth. Many of these experiences, however, emerge under certain unusual conditions in which our later acquisitions become temporarily affected. Evidently these youthful experiences were not lost but rather their arousal was prevented by the more dominant activities that were acquired in later life. The following incident may be cited as an example. A young lady while coming out of the influence of ether began talking in French and was engaged in conversation by her surgeon. Upon visiting her the following day, he spoke to her in French, and to his surprise she failed to respond to his greeting and informed him that she had no knowledge of the language he was speaking. Naturally the patient was also considerably mystified when told that she had conversed quite fluently in French while under the influence of ether. From her parents it was learned that the patient, during childhood, had acquired some facility in the use of French but that this language had long since been forgotten. It is thus evident that the habits of French speech had not been wholly lost; they were merely suppressed, or prevented from functioning, by the later acquired and more dominant habits of speaking English. These later activities were temporarily disrupted by the shock of the operation and with their temporary disappearance the older submerged activities proceeded to function. As the patient recovered from the effects of the operation, the habits of English speech returned and the ability to use the French language again disappeared. A case is on record in which two forgotten languages were recovered during an attack of yellow fever. Long forgotten experiences often emerge during spiritualistic trances. It is the later acquired experiences of life that

usually disappear first with the onset of senility, and their loss is usually associated with the revival of many childhood memories. It has been suggested that the phenomenon of second childhood may be partly explained in terms of the recrudescence of childish interest and attitudes as a consequence of the gradual loss of the experiences which were acquired in later life.

Retention and Methods of Measurement. — The amount of material that is retained after a given interval of time may be measured in several ways, — by the method of relearning, recall, recognition, or rearrangement. In the first method, the amount retained is measured by the difference of time required to learn and relearn the material. If the learning and relearning times are ten and four minutes respectively, it is assumed that forty per cent has been forgotten and sixty per cent retained. The Ebbinghaus curve of retention was obtained in this manner. The subject may also be required to recall as much of the material as possible, and the amount retained is measured by the percentage of the material correctly reproduced. In the recognition method, the subject is required to select the items memorized from a larger list which contains them, and the degree of retention is measured by the percentage of items correctly selected. With the rearrangement method, a group of items is memorized in a given temporal or spatial order, and then these items are shuffled and the subject is required to rearrange them in the order in which they were memorized. The amount retained is measured by the correctness of the rearrangement.

As might be expected, the amount retained varies considerably with the method of measurement employed. In general, the recognition method gives the highest values,

with the methods of rearrangement, relearning, and recall following in order. Their relative order, however, varies to some extent with the interval. The recognition and relearning methods give relatively high values for the long intervals.

These various methods do not give any very accurate measure of the degree of retention. As previously noted, experiences may be retained although they can not be aroused under any of the ordinary conditions of life. Such methods may indicate that certain experiences are wholly lost when as a matter of fact they may be preserved with a high degree of fidelity. These methods measure not the degree of retention but rather the extent to which any experience is capable of being revived under the given conditions.

Organic Conditions. — The retention and recall of experiences is dependent upon the integrity and healthful functioning of the nervous system. In the case of diseases which affect the functional activity of the brain, we find a gradual loss of memory and a gradual impairment of all mental functions similar to those that attend senility.

Localized lesions of the brain destroy the capacity to recall certain kinds of experience. The language activities are peculiarly susceptible to such influences. A person may be unable to talk and yet understand the meaning of words when they are presented either to the eye or ear. A person may be unable to recognize words when seen without losing the ability to use these words when the objects are perceived. The ability to read may be lost with no impairment of the ability to understand the meaning of spoken words. Again an individual may be unable to understand words when seen and yet recognize their meaning when he copies them.

A loss of memory often accompanies a severe illness or a cerebral shock. Memory may be lost for a few days or the defect may persist for a considerable period of time. Sometimes only certain kinds of experience are lost. For example, it has been reported that one individual lost all his knowledge of Greek although his memory was otherwise unimpaired. Another person lost merely his knowledge of music. In another case a subject was unable to recognize his family for several days after an accident although in all other respects his memory was apparently normal. Occasionally the loss of memory is confined to those events which occurred during and immediately preceding the accident. Again the subject may lose a large part of all that he has acquired during life. Certain cases are on record in which all acquisitions were lost. The subject was well educated and he lost all the knowledge acquired in college and in his professional training. He was unable to read, talk, or write. He was unable to recognize his friends and the members of his family. He lost all knowledge of the meaning of objects. He was even unable to feed and dress himself. In fact, he was almost as helpless as an infant. The subject had to be reëducated. He learned readily and soon acquired motor control and learned to talk and recognize the objects with which he came in contact. He was again taught to read and write, and he made rapid progress in acquiring a scholastic education. During all this time the subject was unable to recall any of his experiences preceding the accident. After several years these forgotten experiences began to return and they soon became properly organized in relation to his later acquisitions.

Very striking losses of memory sometimes occur with no obvious cause. A person who is apparently in good

health may suddenly lose all knowledge of who he is and his place in the world. He suddenly confronts the world in the rôle of an utter stranger. He does not know his own name, his past history, his business, his family, and his associates. He has lost all orientation with the world and is forced to cultivate new acquaintances and seek new means of making a living. Such lapses of memory may persist for a number of years.

These temporary losses of memory are obviously due to dissociation. The forgotten experiences can not be revived because they have lost for some reason their normal associative connection with all other items of the subject's experience. The alleged cases of ' alternating personality ' represent very striking examples of dissociation. A much quoted case is that of a young woman who developed two mental conditions which alternated from time to time. In the first condition, the subject was serious, grave, reserved, and industrious, and could remember all events that transpired while she was in either condition. She was gay, imaginative, vivacious, and coquettish while in the second condition, and was able to remember only those events that occurred at the times she was in the second condition. Other cases have been described in which the subject while in one state had no knowledge of whatever occurred while she was in the other state. In other words the subject developed two systems of experience that had no memory connection with each other.

Environmental Conditions. — Recall depends upon environmental conditions. All experiences are revived in virtue of their direct or indirect association with some sensory stimulus. Any experience can be reinstated only in those environmental situations with which it is associated. Most experiences have some indirect association with every

environmental situation and theoretically can be revived under any set of circumstances. Practically, however, an experience can be recalled most readily in those environmental situations with which it has the most direct, the strongest, and the most numerous associations.

As a rule any activity can be most readily reinstated in that situation in which it was acquired because the two must necessarily become directly associated. This principle has been confirmed by experimental means. Animals that have learned to run a maze perfectly make many errors when the objective environment is suddenly altered, or when the maze is transported to a new environmental situation. Memory material that is learned in one environment is relearned more readily in the same situation than in a different environment. A novel situation also affects the verbal recall of memorized materials. Subjects who memorized material in a certain room and in the presence of a given experimenter make poorer records when tested for recall by another person in a different room than they do when tested under the conditions that obtained when the material was memorized.

Many illustrations of the above principle may be drawn from everyday life. A person long absent from his early home environment will experience considerable difficulty in recalling the various incidents connected with his youthful activities, while his mind will be flooded with such memories upon a return to these familiar scenes. The truth of the following incident is vouched for by an acquaintance. An individual lived for several years in China and laboriously acquired the ability to speak the Chinese language. Upon his return to this country for a couple of years' vacation he found to his dismay that his ability to speak and understand this language had practically dis-

appeared by the end of this time. Naturally he expected that a considerable amount of effort and time would be required to relearn the language, but to his surprise he found that he was able to speak the language quite fluently upon his return to China.

A somewhat similar principle is involved in the following incidents. Somnambulists, while in their normal condition, are usually unable to recall the events that transpire during a somnambulistic attack. Yet the events that occur during a period of somnambulism are often recalled during a subsequent attack. There is the old story of the Irish porter who misplaced a package while drunk and was able to recall its location during a subsequent period of drunkenness. Experiences that occur during hypnotic and spiritualistic trances can be revived in a subsequent trance condition although they can not be recalled during the intermediate normal state. Alternating personalities exhibit the same phenomenon. Experiences that occur while the subject is in one condition can often be recalled only during a recurrence of this same condition. In other words, events can be recalled only in those situations with which they are associated.

Experiences can be revived, however, in other circumstances than those in which they were acquired. As has been frequently stated, all activities that are acquired in one situation are likely to be elicited in any similar set of circumstances, and obviously all environmental situations are similar in certain respects. As a general rule we may say that the speed and accuracy with which a given material can be recalled in a novel environment will be proportional to the similarity of those conditions to those that obtained when the material was learned.

The possibility of recalling any item of experience in

novel situations is also a function of the character of the associations that are established during its acquisition. Memorized materials may be readily reinstated in any objective environment in so far as the subject associates this matter with some aspect of his own person, — with some intra-organic stimulus, with some motor attitude, or with the sight of any part of his body. This principle explains the efficacy of the practice of tying a string on one's finger as an aid to memory. Naturally the item to be remembered becomes associated with the sight of the string, and the persistent presence of this visual stimulus serves as a constant reminder of that which is to be recalled. The likelihood of recalling materials in any objective environment is also proportional in a general way to the number of ideational associations that are established. Such associations obviously furnish all sorts of indirect connection with the external world. In acquiring knowledge, one should also attempt to associate it by means of thought with those prospective situations in which it will be used. In order to ensure its permanent retention, mathematics should be taught not as an end in itself but in terms of its potential application to the future needs of the students, with some reference to their prospective vocations in life. In order to be reminded of some errand to be performed on the morrow, a person should associate this task by means of thought with some feature of his daily routine of activity. By means of thought, a person can always associate an experience with any situation in which he desires to recall it.

Theories of Retention. — The generally accepted theory conceives of retention in terms of a structural modification of the organism. Acts are gradually perfected by successive repetitions, and it is assumed that each repeti-

tion leaves certain effects upon the structures involved so that they will respond more readily in a similar manner. When the act is fixated, the cumulative effects of the successive repetitions persist and the subject retains the ability to respond in a similar manner on a subsequent occasion. For a more extended discussion of the nature of these persistent effects the reader is referred to chapter XV. All matter exhibits retentiveness of this sort. When a wire is once bent, its molecular structure is so altered that thereafter it will bend more readily than formerly. A child grasps a flame and is burned, and the pain induces a new mode of reacting to the fire. When this new reaction is thoroughly established, the child will react to the sight of the flame as though the pain were present. A student develops certain ways of reacting toward his instructor in class, and these old reactive attitudes are awakened and influence the student's behavior when the instructor is encountered in other situations. In other words, we encounter any object in a great variety of circumstances and develop ways of reacting to it that are appropriate to those circumstances, and these old habits persist and may be partially aroused and influence our behavior in respect to that object in new surroundings. Stated in terms of experience, the arousal of these former reactive attitudes endows the object with meaning and we respond to the object on the basis of this meaning. Likewise, thoughts represent the indirect and partial arousal of old ways of reacting to objects when they are no longer present. According to this conception, no mental act, no experience ever persists as such; it merely leaves certain neural effects that endure and modify the character of our subsequent activity.

An older theory is similar in all respects to that which

we have just described with the exception that it assumes that all mental acts leave their effects upon some hypothetical substance, — an immaterial mind or soul. This theory has been rather generally discarded in view of the fact that retentive ability is seriously affected by all diseases and injuries of the brain and by all organic conditions that temporarily disturb its normal activity. Furthermore, we know that retentiveness is a property of all material substances.

The third theory assumes that all experiences are entities or combinations of entities that persist and endure in some hypothetical subconscious region of the mind and from which they again emerge from time to time. This conception found many adherents in times past (p. 182), and traces of the doctrine are frequently encountered in present day writings. There is much that suggests such a notion. When we turn psychologist and begin to study our own experiences, we necessarily apprehend them for the time being as objects and hence are prone to think of them as enduring things like material objects. The very terms recall, revival, and reinstatement of experiences also imply such a conception. Moreover, any repetition of a mental act is the *same* experience for all practical purposes. Theoretically, however, any experience is an act or event that does not continue to exist as such any more than does the vibration of a piano string when it is dampened. In the words of William James, "a permanently existing 'idea' or 'Vorstellung' which makes its appearance before the footlights of consciousness at periodical intervals, is as mythological an entity as the Jack of Spades."

The Nature of Forgetting. — Forgetting is sometimes to be explained in terms of defective retention. We are unable to recall an experience because the organic effects that

condition its reinstatement have undergone a process of disintegration. This disintegrative process may be due to the ravages of time, the onset of senility, a nervous shock, the use of drugs and to the effects of disease. Retention may be either permanently or temporarily affected by such influences.

Forgetting may also be due to the inability to recall rather than to any defect of retention. We may be unable to reinstate any given material because of a lack of an associative connection with the present situation. Either such associations were not established, or the two have later become dissociated. Examples of dissociation have been cited in the previous pages. The inability to recall a given material may also be due to its repression by later acquisitions. The stimulating situation fails to elicit the material because it arouses other experiences with which it is more effectively associated. In our discussion of the motor method of learning (Chap. V), we called attention to the fact that the wrong responses are eliminated only in the sense that their arousal in that situation is prevented by the fixation of the correct response. Various other examples of the repression of one activity by the acquisition of a stronger one have been cited in our discussion of the previous topics.

All problems are solved in terms of past experiences; in other words, all new acquisitions necessarily involve a certain amount of reorganization of our previous acquisitions. It has been suggested that the inability to reinstate a complex activity that we have acquired may be due to the fact that its constituent elements were later incorporated as integral parts of some other activity. Let us suppose that we memorize a list of words, and then employ these words to form other lists which are also memorized. The con-

ception assumes that the memorization of these other lists will interfere with our ability to recall the first one that was learned. This conception, however, may be subsumed under the more general principle of the repression of one experience through the establishment of a stronger system of associations.

Voluntary Control. — The likelihood of recalling any material is a function of the character of the associations that were established at the time it was learned. Materials that are thoroughly associated either directly or indirectly with all the rest of our knowledge and especially with various features of our daily routine of activities will be retained almost indefinitely and can be recalled in almost any set of circumstances. Materials can thus be taught and learned in such a way that they will be effectively retained for a considerable period of time. A college student will retain his knowledge of chemistry in after-life in so far as he associates it with other items of his knowledge and with those prospective situations of life in which it will be of service. In order to ensure any permanent retention, the teacher of mathematics must develop its wider relations to other branches of knowledge and its potential applications to the various problems of life. On the other hand, any subject that is taught and learned as an *isolated* body of knowledge is soon forgotten. Materials that are learned for a specific occasion and are associated by means of thought only with that event can be readily remembered when that situation arises but are soon forgotten thereafter. For example, I memorize a series of items that I am requested to purchase on the following day when I go down town, and I am able to recall them at the appointed time, but I find that all memory of them has been effaced within a week. Possibly this principle

explains in part the apparent ability of many college students so to master a subject that they are able to pass a satisfactory examination at the end of the term and yet within a month forget the major portion of what they have learned.

Materials can be remembered for long periods if they are reviewed from time to time. Likewise, we can forget materials by ceasing to review them. We can also forget disagreeable events by studiously avoiding all scenes and circumstances that are likely to suggest them. Experiences are forgotten because they are suppressed by later acquisitions. A bad habit is most readily broken when we develop a new interest to take its place. We can forget things which we do not wish to remember by developing other types of interest to occupy our mind. The processes of forgetting and remembering are susceptible to a considerable amount of voluntary control.

EXERCISES

1. In what respects would your procedure differ in memorizing a list of history dates in order to retain them for a year and in mastering them in order to pass a test on the day following?

2. You have prepared to take an examination in history in the forenoon and an examination in chemistry in the afternoon. When you appear for the history examination, the instructor gives you the chemistry examination, and in the afternoon the chemistry instructor supervises your history examination. In other words you take the two examinations at a different time, in a different place, and under different supervision from what you had expected. How would this change of procedure affect your grades? What principle is illustrated?

3. You memorize a list of words, and find that none can be verbally recalled after the lapse of a year. How would you demonstrate that some degree of retention still persists? Can you define retention as the ability to recall?

4. You have finished a course in Italian. A year later you will be examined as to your speaking ability and your ability to translate. You now take a year's course in Latin. What effect will this course exert upon your two Italian examinations? Would the case be different if you studied German in the interval?

5. Illustrate from your own experience the sudden emergence of long forgotten events. Can you explain these revivals?

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CHAPTER XII

THE ORGANIC BACKGROUND OF MENTAL LIFE

An organism exhibits two groups of activities, — those that are concerned more or less directly with the adaptation of the organism to its environing circumstances, and the vital or vegetative or physiological processes that are primarily concerned with the maintenance of the structural identity of the organism. An organism is a reactive unit, *i.e.*, its various activities are organized in reference to a common objective, — the growth, preservation, and welfare of the individual, and the reproduction of its kind. In other words, these mental and vital activities must be regarded as two mutually dependent and interactive groups of processes, and we shall devote this chapter to a brief discussion of some of the more important aspects of this relation.

The Influence of the Vital Activities. — The vital activities exert a very profound influence upon the character of mental development. This influence is exerted in three diverse ways, — through nutritive, social, and sensory channels, and we shall discuss these topics in order.

Mental acts involve an expenditure of sensory, neural, and muscular energy, and obviously this energy must be supplied by the vegetative processes. The fact is so patent that it needs no comment. Mental life ceases when the vital processes stop. Organisms differ considerably in vitality, and these individual differences are partly responsible for many peculiarities of mental development.

Persons endowed with a superabundance of energy are likely to be rather energetic, impulsive, aggressive, confident, assertive, masterful, egoistic, and even somewhat erratic. Various temperamental characteristics may often be traced back to such a source. Superabundance of vigor may also determine a person's interests and occupation and thus indirectly influence the character of his mental development. An extremely vigorous and energetic individual is not likely to choose a monotonous and sedentary type of occupation. The character of the mental operations is usually influenced by the vital changes incident to growth as is illustrated by the phenomena of adolescence, the menopause, and senility.

The dependence of the mind upon the character of the vital processes receives its strongest support from a consideration of abnormal cases. We may mention the delirium of fevers, the effect of drugs, and the irritableness, petulance, and mental inertness of the sick room. Serious mental disturbances and even insanities may be produced by abnormal conditions affecting the nervous system such as nerve lesions, brain tumors, intracranial pressures, blood clots, and local disorders of circulation. It is also suspected that mental disturbances may arise from the abnormal functioning of the ductless glands whose connection with the nervous system is not wholly understood at present. Certain physical defects and disorders such as tuberculosis, heart trouble, malnutrition, and sensory and motor defects often restrict the range of an individual's interests and activities and thus influence the character of his subsequent mental development. The mental effects of these abnormal conditions are usually not serious unless those conditions persist for some time. Defects of long standing often induce deleterious mental

habits and traits that persist long after their instigating conditions have disappeared. Continued ill health during childhood is especially apt to induce some permanent effect, for some of the basic mental traits and attitudes toward life are acquired during this period, and their acquisition is bound to color in some fashion all of the child's subsequent development. Such volitional traits as grit, perseverance, determination, and mental buoyancy have an early genetic origin.

Physical peculiarities also influence an individual's mental development by way of the social channel. The weak and sickly child may be unduly petted and babied at the sacrifice of such mental traits as initiative and self-reliance. The mode of connection is obvious. The child's defect calls out distinctive modes of reaction on the part of its associates, and as a consequence the child soon develops a distinctive mode of reacting to that social situation. The puny and sickly boy is protected from the hard knocks of life with the consequent loss of certain traits that are developed by such an education. His schoolmates treat him differently from others, and as a consequence he comes to adopt a distinctive attitude toward himself. Parents and teachers are apt to overlook or excuse his errors and omissions because of his frailty. They may also excuse his sins of commission and permit the development of mental and moral traits and habits that would be rigidly dealt with in a normal child at their very inception. As a consequence the child comes to excuse himself for his faults and failures at the sacrifice of such virtues as moral and intellectual self-responsibility.

The possession of birthmarks and other physical peculiarities may also influence an individual's mental development. Shyness, sensitiveness, and secretiveness may arise in

this manner. The social connection is obvious in the case of the proud and haughty beauty. The development of such social reactions is not limited to the period of youth. It is no unusual circumstance for adults to take advantage of and to capitalize the public's sympathy for their misfortunes. Physical peculiarities, however, do not invariably induce any significant mental effects. Their social influence may be prevented by the adoption of an intelligent attitude on the part of parents and teachers. Neither is the effect when present always detrimental. The persistent teasing of a boy with unusually large ears may induce an attitude of sullen resentment, or it may promote the development of his sense of humor, his good nature, and an attitude of sympathy and kindliness to others. The type of attitude developed depends upon the way the individual reacts toward the social situation.

These vegetative processes also influence mental development through their nervous connections. The body is sensitive throughout, and the vital activities continually stimulate the somæsthetic nerves of sensitivity. Since all sensory stimuli release neural energy that must find some motor outlet, necessarily these vital activities will influence the organism's behavior in some manner.

Under normal conditions these sensory impulses are successfully integrated for the most part with the ongoing activities of the moment, and therefore aid in energizing them. The vital activities thus furnish a part of the ' drive ' to mental life. The degree to which an individual's acts are invigorated or vitalized by this background of organic sensitivity necessarily varies with all fluctuations of bodily vigor. Lowered vitality can thus produce a corresponding lassitude of mind, while a high degree of bodily vigor is conducive to an energetic response.

The stimuli resulting from unusual and abnormal bodily conditions may exert a distractive effect upon the mental operations. An individual experiences some difficulty in keeping his mind upon a given task while suffering with an aching tooth. As illustrations, the following list of distractive stimuli may be cited: cramps, muscular fatigue, itching, chills and burning fevers, irregular heart action, headache, painful abscesses and tumors, and digestive disorders of various sorts.

These intraorganic stimuli may also exert a directive effect upon the course of thought. The sequence of ideas in revery may be largely determined by the continued presence of some distinctive bodily condition in virtue of its ideational associations (p. 181). The mind of the cold and shivering vagrant naturally turns to thoughts of food and warmth, while a depressive fit of the 'blues' is not conducive to any prolonged consideration of cheerful topics.

The vital processes also furnish some of the fundamental motives of life. A motive has been defined as a persistent dominating stimulus that compels conduct of some sort until an act is aroused that satisfies or alleviates the motivating conditions. Hunger, thirst, and sex are motivating stimuli that arise out of the normal functioning of the vital processes. Motivating stimuli are also produced by abnormal conditions. The various stimuli that were listed as distractive may also function as motives. For example, a slight headache merely acts as a distraction, while a severe one is likely to disrupt the day's work and evoke a course of conduct expressly designed to alleviate it.

Other motivating stimuli arise out of the maladjustment of the organism to its environing circumstances. For example, the normal functioning of the vital processes in

man requires certain constant conditions of temperature, and any extended or pronounced deviation from these conditions awakens a sensory stimulus that operates as a motive. The extent to which these motivating stimuli determine the character of our social and mental development can hardly be exaggerated. Hunger motivates all of the various activities immediately involved in the production, distribution, and preparation of food. Clothing, heat, and shelter arise in part out of man's need for an equable temperature. The activities involved in the satisfaction of these two motives constitute a very large part of the industrial operations of society, and these industrial operations in turn stimulate the development of accessory industries and arts, promote the development of the material sciences, influence our national antagonisms, increase our social contacts, aid in the dissemination of knowledge, and give rise to many problems of politics, law, and social welfare. These economic motives tinge practically every aspect of mental life. The sex motive also has its wide ramifications. It exerts an influence upon dress, social customs and manners, art, literature, and law. It is indirectly responsible for the family organization of society and the various agencies concerned with the education and care of the young. The motives arising from the abnormal conditions of the organism are largely responsible for the development of sanitary knowledge and the medical sciences, the construction of sanitariums and hospitals, the manufacture and sale of drugs and medical supplies, the profession of nursing, etc. If man were suddenly freed from the necessity of satisfying these four fundamental motives, the character of our civilization would soon be altered beyond the point of recognition.

The Influence of Mental Activity. — The mental opera-

tions, in turn, indirectly affect the vital processes through their adjustive consequences, through the satisfaction of their motivating conditions. The primal motives of life are often called organic needs because their satisfaction is essential or necessary to the continued welfare and existence of the organism. The vital processes can not long continue without food, and painful conditions and injuries must be avoided or remedied if the organism is to thrive. Furthermore, any adequate and proper satisfaction of these motives presupposes a considerable amount of mental development. For example, the healthful operation of the vital processes is contingent upon temperate habits of eating and a properly balanced diet. The exercise of restraint and temperance, the development of dietary knowledge, and the production, distribution, and preparation of foods are tasks that involve a considerable amount of intelligent direction, and we have still much to learn in this respect. In fact the whole course of mental development may be defined as a process of discovering and establishing more and more complex and efficient ways of satisfying the various motives of life.

Mental acts also directly influence the vital processes by means of their neural connections. For purposes of illustration, we shall cite an extreme case. A person when several blocks distant sees his train pulling into the station and decides to run in order to catch it. This adaptive response to the situation automatically induces certain profound changes in the character of the vital processes. The heart beats more violently, the blood circulates more vigorously, the volume of blood is increased in those parts directly involved in the act at the expense of the amount supplied to the abdominal regions, the breathing is quickened, the digestive operations are affected, and the activ-

ity of the sebaceous and sweat glands in the skin is accentuated. Intense intellectual effort, mental worry, and unexpected and painful stimuli also induce certain organic effects that are readily observed. With the use of proper recording apparatus, some slight organic disturbance can usually be detected with every pronounced change in the character of the mental operations.

Mental acts not only influence the vegetative processes by means of their neural connections, but as we have previously noted the organic activities in turn affect the mental operations by way of the nutritive and sensory channels. Furthermore, these two groups of activities frequently interact upon each other in a mutually adaptive manner. First, the mental operations are frequently adapted to the temporary needs of the organic activities, as when we refrain from indulging in any strenuous form of mental effort immediately after partaking of a hearty meal. On the other hand, we are so constituted that the organic activities are automatically adjusted to the character of the behavior situations that confront us. As an example, we shall call attention to the adaptive significance of the organic activities involved in running to catch the train. This strenuous activity necessarily involves the expenditure of an unusual amount of vital energy, and the vegetative processes are automatically readjusted so as to supply this demand and promote the more rapid elimination of the waste products.

Certain of these organic readjustments to mental situations constitute what we term our emotions and moods, — classes of phenomena that are sufficiently important to deserve some extended consideration. As a basis for our discussion, we shall describe in some detail several typical forms of these emotional reactions.

Anger. — The primitive stimulus to anger and its more vigorous manifestation of rage is a sensory situation which constitutes a serious obstacle to freedom of movement, and the emotion consists of an organic readjustment by means of which the surplus energy of the organism is mobilized and concentrated in such a fashion that the organism is able to overcome this obstacle by reacting to it in an extremely vigorous and energetic manner. Watson has found that anger can be provoked in a babe by holding its arms and legs when it is disposed to move them, and by holding its nostrils and thus interfering with its breathing activities. The emotion that is induced by these circumstances consists of an organic readjustment by means of which the babe is enabled to overcome these restraints by reacting more vigorously and energetically than otherwise. Obstacles arouse the emotion on the one hand, and it in turn aids the organism in overcoming them. Anger is thus a preparatory adjustment, interpolated between the stimulus and the overt response, that enables the organism to react to the stimulating situation in an aggressive and impetuous manner.

Certain features of this emotional readjustment are readily observed. It involves a more vigorous action of the heart, quickened breathing, and a concentration of blood supply to those sensory, neural, and muscular mechanisms engaged in reacting to the stimulating situation. The flushing of the face so characteristic of anger and rage is due to this onrush of blood to the reacting parts. Blood is withdrawn from the visceral regions and the digestive operations are temporarily impeded as a consequence. These digestive disturbances may be quite pronounced in the case of a prolonged fit of rage. It is also possible that the emotional reaction comprises other important features

that can be detected only by the aid of physiological experimentation. For example, Cannon has concluded on the basis of an extensive series of experiments that anger as well as fear involves the excitation of the adrenal gland whereby an increased amount of adrenalin is secreted directly into the blood. The presence of adrenalin in the blood is supposed to exert two effects. It causes the blood to coagulate more readily, and it stimulates the liver to secrete its stores of glycogen directly into the blood in the form of a sugar compound that constitutes the most readily available form of neuro-muscular energy.

The significance of these processes is now apparent. The release of the store of energy and its concentration in the reacting parts by means of the vaso-motor changes account for the vigor and impetuosity of the organism's reaction. In primitive conditions of life, the situations that evoke anger are usually those that involve personal combat, and the alleged coagulating effect of adrenalin is supposed to be of service in preventing an excessive loss of blood in these encounters. Cannon's basic conclusion that an unusual amount of sugar is present in the blood during periods of emotional excitement has not been confirmed by other competent investigators, and until this question of fact has been settled we must adopt a sceptical attitude toward this theory. The controversy does emphasize the need for a systematic physiological analysis of the emotions, and it suggests the possibility that they are much more complex than our perceptual experiences of them would indicate. However, we must not lose sight of the fundamental fact that these organic readjustments involved in anger are conducive to an energetic and impulsive type of conduct.

This emotional reaction is susceptible to the influence

of training and experience, and we find that it becomes considerably modified in the course of individual development. While we do not learn how to get angry, yet we do learn what to get mad at, when to refrain from anger, and how to manifest it in more effective ways. The primitive tendency to respond emotionally to a given stimulus is strengthened by repetition, and it will be weakened and finally eliminated for all situations that involve deleterious consequences. By becoming associated with new types of stimuli, the emotion will be aroused by situations that normally do not evoke it. Obstacles to movement are the primitive incentives to anger, but with the development of experience the range of potential stimuli is considerably extended. Anger in the adult is likely to be provoked by any condition that seriously interferes with the attainment and preservation of valued ends. Distractions and interruptions while we are diligently engaged in study or hastily dressing for a party are apt to evoke sudden flashes of anger. Any interference with valued ends once they are achieved is resented. Social humiliations, attacks on our self-respect, meddling with our private affairs, reflections on our honor and integrity, and sneers at our religious and political beliefs are conducive to anger. Anger may also be evoked by an attack against those things in whose welfare we are intensely interested, such as a malicious injury to a pet dog, injustice to friends and relatives, sneers at our church or country, or hostility to some pet social program. Anger is not exclusively aroused by and directed toward persons. We may become angry at inanimate things, imaginary conditions, social programs, and social institutions.

Neither is there any definite and invariable method of venting anger, for the resultant act is varied to suit the

provocative circumstances. We kick a dog, throw missiles at a cat, slam an inoffensive door, and fight in a more conventional manner when dealing with persons. Caution is exercised with the development of experience and our rage may be vented by means of taunts, threats, sarcasm, and verbal abuse. The act may also be postponed for a more opportune occasion or in order to devise some devious and indirect way of injuring or humiliating our opponent. Anger may also be simulated in order to cow an opponent and thus achieve our ends. There are as many ways of venting anger as there are ways of arousing it.

The character of the organic readjustment also varies with circumstances. The violent and tumultuous organic disturbance previously described represents the primitive and unsophisticated adjustment preparatory to an immediate and vigorous muscular effort. No such pronounced disturbance is likely to occur after we have developed the habit of postponing vengeance and venting it in more subtle ways. For many situations, the organic reaction becomes considerably weakened and curtailed because of the inhibitory influence of its social consequences. Again we find it advantageous to repress or conceal our anger on many occasions. We also find it useful at times to simulate anger, and these habitual attitudes may be incorporated into its normal expression. For these reasons, anger in an adult exhibits various gradations ranging all the way from its primitive form to a type in which but little or no organic disturbance is present, and which may be characterized primarily as a hostile mental attitude reflected in such features as clenched fists, set jaw, flashing eyes, raised voice, and a grim and determined expression. Such terms as rage, anger, hatred, resentment, sullenness, indignation, peevishness, and irritation are employed to designate the

more obvious distinctions within this series of emotional reactions.

Some writers minimize the importance of anger in mental life and intimate that it exerts no appreciable influence upon behavior. Such a view is wholly untenable. A per on when thoroughly enraged can often perform feats of strength of which he is wholly incapable under ordinary circumstances. An organism when angry acts differently from the way it does on ordinary occasions. Even a child has sense enough to treat an angry person differently from one who is not angry. As we have indicated anger is conducive to a vigorous and aggressive and determined type of attack against any difficulties that may be encountered in the attainment and preservation of valued ends.

The student must not confuse the worth and utility of anger in achieving and preserving ends with the ethical value of those ends. Anger is conducive to an effective type of conduct, but the consequences of that act may be either good or bad. Anger may lead to an act of crime or it may culminate in an aggressive attack upon some social evil. Neither do we maintain that an aggressive and impetuous attack is always the best means of overcoming an obstacle. Anger often defeats its own purposes. This emotional type of reaction, however, has its values. Smouldering resentment and a final outburst of wrath are sometimes necessary for the overthrow of an established form of social injustice. All emotional reactions need to be subjected to a considerable amount of training if they are to be utilized effectively in the interest of social ends.

Fear. — Much that has been said about anger is also applicable to fear. The range of stimuli that evoke the emotion in adults is largely a product of experience. Watson found but two classes of stimuli that are capable

of arousing fear in an infant, *viz.*, loud noises and insecurity of support. He also found that the emotion readily becomes associated with any simultaneously experienced object. By means of a loud noise, fear was evoked in an infant while it was looking at a rabbit, a doll, or some other harmless object, and it was found that after a few repetitions the sight of this harmless object would arouse the emotion when the sound was not given. The fear aroused by heavy thunder naturally becomes associated with the flash of lightning, and this fact in turn may account in part for the childish fear of the dark. Many of the trivial and irrational fears of childhood are acquired in this roundabout fashion. Fear also becomes attached to objects by means of ideas. Children learn from their elders that certain things are regarded as fearful. Fear associations in children are often inculcated by the chance remarks, attitudes, and actions of their elders. Some of the irrational fears of children are due in part to foolish and unintentional remarks or actions on the part of parents and nurse maids. Society intentionally instills certain fears and eliminates others. Parents attempt to eradicate the irrational and imaginary types of fear by the development of some sort of rational inhibition. Fear is often regarded as a childish weakness that should be repressed in order to develop courage.

Social agencies inculcate fear as a means of regulating conduct. In times past the Church was accustomed to instill a fear of the Lord and his vengeance. Autocracies have employed fear to hold rebellious people in subjection. Capital punishment has been used for its deterrent effect upon crime. Some parents and teachers also attempt to rule by fear. Fear of fire, water, and speeding automobiles is inculcated in order to induce a more cautious attitude

toward them. There is thus no natural association between fear and dangerous situations. A knowledge of what constitutes a dangerous situation and the association of fear with that situation are for the most part products of experience or training. The danger does not need to be perceptibly present in order to arouse the emotion. Fear will be provoked by any situation in which danger is expected or imagined, and it is these immediately prospective dangers that are usually the most terrifying.

The manner of acting when afraid varies with the provocative circumstances. Fear does not always culminate in flight as is so often assumed. It may induce one to avoid situations in which danger is suspected, or it may induce a more cautious, alert, and circumspect attitude in dealing with dangerous situations. Again the individual may become weak and helpless and incapable of responding to the situation except with screams of terror, and this paralysis of fear may on occasion culminate in a faint. It is sometimes assumed that the paralysis of fear is a survival of the 'death feigning' phenomenon prevalent among many of the lower animal forms. Feigning death or 'playing possum' is regarded as a native reaction that aids the organism to survive, for a motionless and inert animal is not likely to excite an attack on the part of its enemies. This genetic conception assumes the existence of two types of fear, — one that promotes flight and one that is conducive to inaction. Paralysis is rather to be explained in terms of the provocative circumstances, for it occurs primarily in those situations in which escape is hopeless or impossible, or in which the point of danger is unlocalized and the subject does not know in which direction to run.

The character of the organic reaction varies with the behavior situation in which it occurs. The fear experienced

when we are able to run is different from that when escape is impossible, and both differ from that involved in acting cautiously in the presence of a potentially dangerous situation. This fact gives rise to such a series of verbal distinctions as terror, dread, fear, timidity, anxiety, and uneasiness. At one extreme we find the presence of a very pronounced and tumultuous intra-organic disturbance which takes possession of every inch of our being. At the other extreme, the disturbance is more restricted, and somewhat incipient, evanescent, and transient in character, and at times the term fear is employed to characterize a condition of intellectual indecision in the face of impending danger.

Fear is thus aroused by any present or immediately prospective situation that is deemed to be dangerous and it is an organic readjustment that is conducive to a prompt and vigorous negative response to that situation. The functional efficacy of fear is attested by the fact that various social agencies, such as the Church, state, and home, have long been accustomed to instill fear as a means of arousing and establishing certain types of conduct. Any individual who is dominated by fear certainly acts in a manner different from that which he displays on ordinary occasions.

Disgust. — Less is known about the genetic development of disgust. It has been suggested that the taste and odor of filthy and putrescent objects are the primary stimuli to disgust, and that the emotional reaction must be regarded as an incipient nausea that is conducive to an overt avoiding response. In the process of development, the emotion becomes associated with the sight of filthy objects, unsanitary conditions of life, uncleanliness of person, unhygienic habits, obscenities of speech and action, and it has also been utilized in the establishment of certain taboos con-

nected with sex. Undoubtedly it is the alimentary mechanism that is primarily involved in the emotional reaction. Disgust and fear are thus conducive to similar types of behavior, but they differ very materially in respect to their organic nature and the range of stimuli to which they are susceptible.

Joy. — Joy is awakened by the sudden and unexpected attainment of very desirable ends. In general it consists of a rather widespread and exhilarative organic reaction involving especially the vaso-motor mechanisms and accompanied by a great variety of motor manifestations. The emotion varies considerably in strength and in the character of its motor accompaniments according to the nature of the provocative circumstances. For example, the joy of religious ecstacy differs from that involved in achieving academic success. Joy differs from fear and anger in that it has no adaptive significance. As we have noted, fear is aroused by a dangerous situation and it influences the organism's reaction to that situation. Joy, on the other hand, is aroused by the attainment of desirable ends and hence it can be of no service in enabling the organism to achieve those ends. This statement does not mean that the emotion does not influence the organism's behavior; it may exert either a beneficial or a detrimental effect upon the organism's subsequent behavior to other situations.

Surprise. — The emotion of surprise is evoked by any sudden, unexpected, and unusual situation to which we are unable to react for the time being in any coördinated fashion. Because of the absence of a coördinated response, the neural impulses awakened by this intensive form of stimulation necessarily overflow into the visceral channels and arouse a very pronounced organic disturbance of either a depressive or exhilarative character. The type of effect

induced apparently varies with the nature of the stimulating circumstances. Surprise, like joy, must be regarded as an incidental by-product of a mental situation that has no value in enabling the individual to react to that situation in an effective manner.

Some Interpretative Principles. — As we have noted, an organism is a reactive unit, and the mental and the vital activities are so intimately related that they are continually influencing each other in various ways. Obviously such a connection is a necessary and a biologically useful arrangement. The biological utility of this arrangement, however, does not mean that these two groups of activities invariably influence each other in a mutually adaptive manner, or that each effect has any very direct bearing upon the survival or welfare of the organism. The emotions represent but one of the ways in which these two groups of activities influence each other. In other words, the emotions constitute a special class of a wider group of phenomena. This conception frees us from the necessity of assuming that each emotion is a biologically useful reaction. As we have indicated, some emotions like anger and fear have a biological significance while others like grief and joy do not. Even the same emotion may be beneficial in some circumstances and not in others.

We may contrast our conception with the more orthodox doctrine which assumes that the various emotions are distinct mechanisms that have been independently developed in the course of evolution. The supporters of this doctrine are confronted with the necessity of assigning a distinctive biological value to every emotion. As we have indicated, such a conception encounters insuperable difficulties in its treatment of such emotions as joy, grief, and surprise.

The conventional doctrine also assumes that each emotion represents a distinctive and unique combination of organic events that we can invariably recognize and identify on any occasion. For example, it is assumed that fear and anger so differ in their organic nature that we are able to distinguish between them irrespective of any difference in the behavior situations in which they occur. This doctrine is well illustrated by the following quotations from James: " Were we to go through the whole list of emotions which have been named by men, and study their organic manifestations, we should but ring the changes on the elements which these three typical cases (grief, fear, and hatred) involve. Rigidity of this muscle, relaxation of that, constriction of arteries here, dilatation there, breathing of this sort or that, pulse slowing or quickening, this gland secreting and that one dry, etc., etc. We should, moreover, find that our descriptions had no absolute truth; that they only applied to the average man; that every one of us, almost, has some personal idiosyncrasy of expression, laughing or sobbing differently from his neighbor, or reddening or growing pale where others do not." " The various permutations and combinations of which these organic activities are susceptible make it abstractly possible that no shade of emotion, however slight, should be without a bodily reverberation as unique, when taken in its totality, as is the mental mood itself." [1]

On the contrary, we wish to suggest that the various emotions can be readily identified and defined only in terms of the behavior situations in which they occur rather than on the basis of their organic composition. In other words, an organic readjustment is identified as fear primarily because it is aroused in connection with our flight from an

[1] James, Principles of Psychology, Vol. II, pp. 447 & 450.

impending danger, while this same organic reaction would not be so labelled if it occurred in connection with a different type of behavior situation. Several arguments may be advanced in support of this proposition.

1. Practically all writers first identify the emotions in behavior terms, and then describe their organic nature. No one makes any pretense of identifying them on the latter basis. Even James calls attention to the fact that "in the dictionaries of synonyms we find these feelings distinguished more by their severally appropriate objective stimuli than by their conscious or subjective tone."[2]

2. Again we may express some degree of scepticism concerning the ability of any observer to describe in organic terms such a series of emotions as anger, fear, joy, surprise, sorrow, and elation so that they can be correctly identified by the average reader.

3. The organic nature of an emotion varies considerably with individuals. This fact was well stated in our first quotation from James.

4. As noted in our previous descriptions of anger and fear, the character of the organic disturbance varies with circumstances. The paroxysm of terror and a mild form of fear probably differ to a far greater extent than do many cases of anger and fear.

5. As organic adjustments fear and anger are much alike. Their fundamental similarity is indicated by the fact that they may rapidly alternate during the varying exigencies of personal combat. At one moment an individual is thoroughly embued with rage, and this condition is rapidly succeeded by a moment of genuine fear as the combat temporarily goes against him. Likewise, an animal dominated by fear may suddenly turn upon its antagonist with every

[2] Ibid. p. 448.

manifestation of rage. These rapid transitions from one emotion to another are hardly explicable on the assumption that they represent two radically different types of vital readjustment. Fear and anger are often called antagonistic emotions. They do not represent two antagonistic groups of organic processes, however. They are antagonistic only in respect to their behavior situations. Anger is correlated with an aggressive attack against obstacles, while fear is associated with the opposite type of behavior.

The above doctrine does not mean that all emotions are alike in respect to their organic composition. Certainly disgust is a type of reaction different from fear or anger. Grief likewise differs from joy. As we have indicated, the nature of the organic response necessarily varies with the provocative circumstances and the individual's reaction in reference to them. In other words such organic differences as do exist are due to differences in the behavior situation. It is the behavior situation that constitutes the primary and distinctive characteristic of an emotion.

The emotions are usually classified in respect to their behavior situations. Fear, anger, and love are regarded as distinctive emotions for this reason, while terror, panic, horror, dread, fear, fright, alarm, dismay, consternation, trepidation, timidity, anxiety, and uneasiness are grouped together because of the similarity of the behavior situations. The emotions can also be classified on the basis of their organic nature. Such classifications as sthenic or asthenic and depressive or exciting have been suggested. It is also customary to classify the emotions in respect to their alleged primary or elemental character. Certain emotions are regarded as primary and fundamental, while others are said to be compounds and derivatives of these primary ones. For example, horror is sometimes regarded

as a compound or mixture of fear, anger, and disgust. The validity of this mode of classification may be questioned. According to our conception, there are just as many kinds and varieties of emotions as there are distinctive behavior situations, and one emotion is just as unique and primary and fundamental as another. The attitude of horror is similar to those of fear and disgust, but it can hardly be regarded as being composed of them.

As previously noted, the emotions constitute a special type of organic readjustment, — an important and significant fact that is usually ignored in the discussions of this topic. For example, the emotions are quite similar in most respects to the organic readjustments that accompany any form of vigorous exercise. Any strenuous activity such as running to catch a train necessarily involves the expenditure of an unusual amount of energy, and the vegetative processes are automatically readjusted so as to supply this demand and promote the more rapid elimination of the waste products. The heart beats more violently, the blood is increased in those parts directly involved in the act, the breathing is quickened, and the activity of the sebaceous and sweat glands is accentuated. Obviously, this reaction is essentially similar in both nature and function to that involved in anger, and yet we label one an emotion while the other we do not. It is thus necessary to distinguish the emotions from other types of organic readjustment.

In the act of running for a train, the stimulating situation arouses the act, and the organic adjustment is the consequent of that act. The readjustment arises gradually, it develops in an orderly fashion, and it is adapted to the varying exigencies of the act. In anger, any overt form of response to the stimulating situation may be inhibited for the time being and the organic readjustment

precede the act. Because of the lack of any adequate motor outlet, the emotional readjustment develops in a more tumultuous and impulsive fashion. Our whole being seems to seethe and boil with rage, and this condition of organic turmoil is followed by an explosive moment as this pent-up energy is finally discharged into action. After we begin to react to the situation, we may experience for a short time these surges of emotional excitement that sweep us on to more vigorous efforts. In the case of running to catch a train, the organic reaction is awakened by the response and it is adapted to that response. In fear and anger and similar emotions, on the other hand, the organic reaction is awakened by the provocative circumstances, and our response to that situation is largely determined and dominated by these tumultuous organic impulsions. Likewise in the non-adaptive emotions such as surprise and joy, the absence of any adequate motor outlet is conducive to a somewhat disorganized and tumultuous organic reaction, and necessarily we become acutely conscious of these visceral disturbances.

The emotional reactions thus occur in the absence of any correlative act, or they develop and run their course with some degree of independence of the act and hence largely determine the character of that act. We thus suggest that it is these surging, seething, tumultuous, impulsive, and explosive features that constitute the distinctive characteristic of an emotional type of organic readjustment. Thus an emotion may well be called an organic commotion. In support of this conception, we may call attention to the well known fact that the emotions tend to disappear with action. Our anger soon cools and wanes when we begin to fight, and terror no longer holds us in its grip when we indulge in strenuous flight. The difference between

these two conditions does not consist of the presence and absence of an organic disturbance, for both fighting and flight obviously involve a very pronounced readjustment on the part of the vital activities. Evidently the disappearance of the emotions with overt action is due to a change in the character of the organic reaction. Given an adequate motor outlet, these organic activities gradually become adapted to the exigencies of the act, and hence they lose their initial tumultuous and impulsive character and the experience is no longer labelled an emotion.

The James-Lange Theory. — Previous to the time of Lange and James, the organic reaction was regarded as the expression or manifestation of the emotion, and this in turn was regarded as a unique and unanalyzable experience that was directly excited by the stimulating situation. James and Lange denied the existence of this unique experience and identified the emotion with our experience of these organic responses. Our conception differs from that of James in two respects.

1. James defined mind in terms of consciousness or the psychical aspect of the adjustive operations, and hence he identified the emotion with the sensuous experience of our reaction to an emotional stimulus. According to our conception, the emotions are psycho-physical events (Chap. I). An emotion does not consist of these organic reactions as abstracted from our experience of them, and neither are they to be defined in terms of experience as abstracted from that which is experienced. The emotion is regarded as an experienced organic event.

2. James made no distinction between the organic readjustment and the individual's overt response to the stimulating situation. Hence James identified fear with the sensuous experience of the act of running as well as of the

organic accompaniments of that act. Since we can not experience an act until after it occurs, James was led to make his famous paradoxical statement that we do not run from a bear because we are afraid, but that our fear is a consequence of our flight. According to our conception, the emotion is to be identified with the organic readjustment, and consequently it is legitimate to assert that fear is partly responsible for our flight.

Moods. — Moods differ from the emotions in that they represent relatively stable and more enduring organic conditions. They are often called weak and persistent emotions. In general, moods reflect either a healthful, tonic, and exhilarating, or a somewhat retarded, sluggish, and unhealthful condition of the vital processes. Kindly, sympathetic, cheerful, gay, and happy moods belong to the first class, while the latter condition is represented by 'grouchiness,' sulkiness, irritability, pensiveness, melancholy, gloom, depression, and fits of the 'blues.'

Moods are variously aroused. They often develop from some previous emotional state. A strong fit of anger may finally subside into a sullen, irritable, and resentful mood, cheerfulness and gaiety may be the product of an emotion of joy, while a gloomy and melancholic attitude may find its origin in a previous attack of grief. Moods may also be aroused by non-emotional mental conditions. Success is conducive to a cheerful, buoyant, and optimistic mental attitude, while any signal failure is likely to induce a gloomy, melancholic, or resentful attitude toward the world. Moods may also arise from overwork, mental fatigue, monotony, undue excitement, and excessive worry. Finally, moods have a physiological origin. Peevishness, irritability, and despondency may be due to mild disorders of digestion and circulation, while any unusual degree of vitality and

bodily vigor is conducive to a cheerful, happy, and buoyant frame of mind.

Moods do not merely tinge or color mental events; they also exert an influence upon the character of our thoughts and actions. Obviously, a despondent and melancholic individual will react to a social situation in a manner entirely different from that of a person who is in a happy and cheerful frame of mind. Any particular mood must necessarily acquire during the course of experience a great variety of ideational associations (p. 182), and hence the continued presence of that mood will naturally exert an influence upon the sequence of ideas.

The phenomena of moods thus illustrate very nicely the mutual dependence and interaction of the mental and the bodily activities. On the one hand, the course of mental events is often shaped by moods of a physiological origin. Likewise, any mental situation that is responsible for a prolonged attack of gloom and despondency must have exerted a depressing effect upon the vital operations, while all situations that arouse a buoyant and cheerful mental attitude exert a stimulating and tonic effect upon the vital processes. Continual worry and excitement, and prolonged fits of melancholy and despair are not conducive to the normal functioning of the vegetative processes. Not only does a sound mind presuppose a healthy body, but a sane and optimistic attitude toward the world is just as essential to the continued welfare of the physical organism.

EXERCISES

1. Write out a detailed description of pity, awe, and grief.
2. How do you distinguish one emotion from another? How do you distinguish an emotion from a non-emotional organic disturbance? Give concrete examples.

3. Give some experiences in which your anger detrimentally affected your reaction to a situation.

4. Would you appeal to fear in training a child to be courageous? Justify your answer.

5. Should society attempt to eliminate fear and anger from human nature? Can it be done? Would it be advisable to do so if it were possible? Should grief be eliminated? What good do you think it is?

6. Do you know people who are too emotional? Do you know people who are too unemotional? What is the basis for your answers?

7. Does the doctrine of evolution imply that all native reactions are biologically useful? Justify your answer.

8. To what extent and in what ways can your mind influence your bodily health? Do physicians try to keep their patients in good mental spirits? Why?

9. Is the proper training of the emotions just as important an educational task as is the training of the intellect? Does the training of one necessarily involve that of the other? Justify your answer.

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CHAPTER XIII

THE AFFECTIVE AND EVALUATING ASPECTS OF EXPERIENCE

Affection refers to those aspects of experiences on account of which we label them as pleasant or unpleasant. An experience which is judged to be neither pleasant nor unpleasant is said to be lacking in affective tone. Four main questions are involved in a consideration of this topic — 1. What is the nature of affection, *i.e.*, what are the distinctive characteristics of an experience because of which we judge it to be pleasant, unpleasant, or devoid of affective tone? 2. What are the various conditions which determine the affective coloring of an experience? 3. What is the function or significance of affection in mental development? 4. What is the relation of affection to the process of evaluation? These questions will be discussed in order, and it may be well to state in advance that there is no unanimity of opinion in regard to them.

The Nature of Affection. — Four answers to the first question have been proposed. First, pleasantness and unpleasantness are regarded as inherent *attributes* of all sensory processes. It is recognized, however, that they differ from such attributes as intensity and duration inasmuch as they are not invariably present, and for this reason they may be termed non-essential attributes. Their occasional presence can be accounted for by several conceptions. According to one conception, nerve cells accumulate

and store energy and the amount available in any cell may vary from time to time. It is assumed that the attribute of unpleasantness is present whenever a sensory process involves an excessive or exhaustive expenditure of energy, while pleasure is present when the amount discharged is considerably less than the amount available. Whenever there is a proper balance between resources and expenditure, neither affective attribute is present. This attributive conception of the nature of affection is not seriously regarded at present.

Pleasantness and unpleasantness are also alleged to be distinctive *sensory* processes similar to those of taste, smell, and vision. According to this view, these items of experience are due to the excitation of specialized sensitive structures, have their own separate nerves and conduction tracts, and should have been considered in the chapter devoted to sensation. Adherents of this conception are thus confronted with the task of specifying the nature and distribution of these nerves. At one time, unpleasantness was regarded as a mild form of pain, and hence due to the weak excitation of a pain nerve, but this view has been rather generally rejected. Pain and unpleasantness are distinctive and not identical terms, for the same stimulus may be both painful and unpleasant. Furthermore it is often asserted that pain under certain conditions may be slightly agreeable. It has also been assumed that the affective nerves are distributed to every sensitive area, — to the skin, the ear, the tongue and the retina, and that these nerves under certain conditions may be excited by any kind of stimulus. If an air wave affects the auditory nerve alone, a sound is heard, but if that stimulus also excites the pleasure nerves distributed throughout the inner ear, the resultant experience will be characterized as a pleasurable sound. Likewise, bitter sub-

stances are unpleasant because they stimulate both the nerves of taste and the affective nerves distributed over the upper surface of the tongue.

This neural hypothesis was devised to account for the generally accepted facts that pleasantness and unpleasantness can be experienced only in conjunction with some other sense object to which they bear an attributive relation and that every modality of sense may be affectively toned. Other writers have assumed that these affective nerves have a very restricted distribution and that they are excited only by the reflex motor or secretory effects of other sense stimuli. An auditory stimulus releases a sensory impulse which may irradiate and induce certain motor or glandular responses in a remote part of the body, and it is these responses that excite the affective nerves. Stimuli from any sense avenue may thus irradiate to the affective nerves, and the affective character of those stimuli will depend upon which affective nerve is excited. One recent writer has asserted that the affective nerves are those involved in sexual excitement and depression. As a matter of fact there is no histological evidence in favor of the existence of special affective nerves, and the conception finds few adherents among present day psychologists.

A third conception assumes that pleasantness and unpleasantness are like sensations in that they are *elemental* processes, *i.e.*, both sensory and affective processes can be varied independently of each other. Certain writers are accustomed to state the differences between sensations and affection in experimental terms. Pleasantness and unpleasantness are said to be mutually exclusive processes while sensations are not. Clearness is regarded as an attribute of sensation but not of affection, or in other words sensory processes are potential objects of attention while affective

elements are not. Other writers state the difference between the two kinds of elements in neural terms. The doctrine of independent variability logically implies a difference of neural basis. Sensations represent the activity of specific neural segments comprising a sense organ, a nerve, and a cortical centre, while it is assumed that the affective processes involve merely the excitation of a distinctive centre. According to this neural conception, a lesion of the affective centre will disturb or destroy the capacity to experience pleasure without necessarily affecting any of the sensory activities. These centres have been variously located on the basis of clinical data. They have been assigned a location in the frontal lobe, and also in the thalamic region by one recent writer. An auditory sensation will thus be affectively toned if the nervous impulse passes through the affective centre, while it will be neither pleasant nor unpleasant if any other pathway is traversed. This elemental conception is the one that is generally accepted at present, and it nicely accounts for the fact that the affective items of experience appear only in conjunction with some sensory process and yet may be observably distinguished from it.

The final view may be termed the *judgmental* conception. It assumes that pleasantness and unpleasantness are attributes which we ascribe to any stimulating situation in virtue of our normal reaction tendency toward it. We are so organized in respect to certain situations that we normally react so as to enhance, maintain, or repeat them. We catch sight of a certain picture and turn our eyes and walk nearer to it in order to see it better, and keep looking at it for some time in order to continue the experience. Such behavior is termed a positive reaction, and any situation that normally evokes such a response is judged to be pleasant. Other situations arouse negatively adaptive re-

sponses, — responses which minimize or rid us of their stimuli and which we do not repeat. Because of our organization in reference to them, certain odors cause us to hold our breath or nostrils, flee their vicinity, and avoid them in the future. According to this conception, any situation that normally arouses such a response is judged to be unpleasant, while all situations that normally arouse neither type of adaptive response are regarded as lacking in affective tone.

It is to be noted that the affective judgments are based upon our normal or typical reaction tendencies toward objects. The theory does not assert that pleasant objects invariably arouse a positive response, or conversely that all objects to which we do react in a positive manner are pleasant. Our responses to objects are frequently determined by some extraneous consideration, and as a consequence we may react positively to unpleasant objects and avoid things that are pleasant. For considerations of health we swallow disagreeable medicines, stop smoking, and refrain from eating foods that we enjoy. The affective judgments are based upon our normal responses to the objects *per se* uncomplicated by any other motivating influence. Since the normal response toward an object may be inhibited or repressed by other motivating factors, it follows that the actual arousal of the response is not always essential to the deliverance of an affective judgment. The affective judgment of a familiar object may be based upon the *meaning* which that object has acquired in virtue of our previous responses to it. The overt arousal of the normal adaptive response is essential to an affective judgment only in the case of relatively unfamiliar things.

Objects may be characterized as things which we like or dislike, and such conative judgments are also based upon

our normal responsive tendencies toward these objects. The conative and affective judgments about objects are thus intimately related inasmuch as both are based upon and characterize the same situation, *viz.*, the relation existing between a stimulating situation and a responsive organism. The two kinds of judgment differ, however, in the fact that they characterize that situation from two different points of view. The affective judgment states the effect which the stimulating object exerts upon the organism, and the conative type of judgment characterizes the organism's normal mode of responding to that object. Pleasure is a term that indicates how the object affects the subject, while such terms as liking and desire indicate the reactive attitude of the subject toward the object as a goal of action. It follows that pleasant objects are things that we like, and that likeable things are also pleasant. The two attributive aspects of an object, however, do not stand in a causal relation to each other, and, strictly speaking, a person can not say that he likes an object because it is pleasant, or that it is pleasant because he likes it, although both expressions are sometimes permissible in popular speech.

Affective judgments may be made about any sort of experiential situation, — a sense object, a muscular act, an intraorganic condition, an object of thought, a process of thinking, a volitional decision, etc. Even the absence of a sense object may be regarded as a pleasant or unpleasant condition. An affective judgment may be made concerning any constituent part of a complex situation, or it may refer to the situation as a whole. Moreover, one part of a situation may be judged to be agreeable, another as disagreeable, and a third as indifferent. A person afflicted with a sore throat may successively regard the taste of a given food as pleasant and the act of swallowing it as un-

pleasant. An individual may like a bit of music as a whole and dislike some of its constituent phrases. A painting viewed as a whole may induce a pleasurable reaction while certain of its aspects may be viewed with disfavor. A person may likewise enjoy the act of attaining some unpleasant end and dislike the effort involved in obtaining some pleasurable result. Erroneous conclusions are sometimes due to a failure to observe such distinctions.

A certain widely accepted doctrine states that objects are pleasant or unpleasant according to whether they further or hinder our desires. I am industriously engaged in the preparation of a lecture and find that my thoughts are being continuously distracted by the music of a band in the distance. The doctrine asserts that this music is necessarily disagreeable because it interrupts my work and thwarts the attainment of my purpose. In the author's opinion, it is not the music that is disagreeable but the fact that I am interrupted; it is the inability to proceed with my work that I dislike. Any statement that the music is unpleasant is due either to a confusion as to what feature of the total situation is being judged, or to the fallacious assumption that an object is necessarily disagreeable because it exerts a disagreeable effect upon the flow of thought.

Determining Conditions. — These conceptions of the nature of affection must be examined in the light of certain factual data concerning the conditions under which the affective aspects of experience are obtained and in the light of their relation to each other and to other items of experience. First, pleasantness and unpleasantness, irrespective of their nature, cannot be experienced in isolation. They occur only in conjunction with some experiential situation and are always regarded as attributes of that situation. Moreover, pleasantness and unpleasantness are mutually

exclusive attributes. Objects are either pleasant, unpleasant, or lacking in affective tone. A given object can not be both pleasant and unpleasant at the same time. These facts are most readily acounted for in terms of the attributive and judgmental conceptions, although they are not inconsistent with the other two theories.

Several experiments have been conducted to ascertain whether one object can be regarded as agreeable and another as disagreeable at the same moment of time. For example, a pleasant tone is selected and it is then presented simultaneously with a disagreeable odor, and the subject is asked to report as to the presence of the two affective qualities. In the great majority of the observations, the affective tone of one object suppressed that of the other, or the two alternated and were experienced in succession. In a few cases, certain of the observers reported that during the periods of rapid alternation there were moments during which both attributes appeared to be present simultaneously. Antagonism and mutual exclusiveness seemed to be the rule however. This fact practically eliminates the attributive theory from further consideration. Pleasantness and unpleasantness are regarded as inherent attributes of sensory objects like their quality, intensity, and duration, and it is admitted that the respective qualities of two sensory processes may be simultaneously observed. Some of the sensory conceptions also encounter difficulty with this fact, for the two alleged sensory mechanisms involved must be so related to each other that only one can be excited at a time. The elementary conception is likewise forced to assume that the two processes involve a single centre which can function in but one of two antagonistic ways. This is similar to Hering's conception of antagonistic colors (p. 55). The fact presents no difficulty to

the judgmental conception, for the organism normally reacts as a unit (p. 76) and hence will usually respond to but one situation at a time.

Innate organic conditions determine the affective tone of many objects. As illustrations we may cite the disagreeable character of pain and bitter substances, and the agreeableness of sweets, certain odors, and musical intervals. These preferences and dislikes are so universal and appear so early in life that they can hardly be regarded as products of experience. The affective tone of some objects may be altered by a change of organic conditions. Organic changes incident to physical growth modify food preferences and account for the rise of interest in objects connected with sex. Tastes for food vary with the season and conditions of health and sickness. Many perverted tastes and cravings find their origin in some abnormal organic condition. These facts present no especial difficulty to any of the four conceptions.

The affective tone of objects is to a large extent determined by the character of a person's experience. Individuals differ radically in their affective attitudes. What is pleasant to one person may be decidedly disagreeable to another. Some people find their keenest pleasure in the theatre, art, or music, others in books or their profession, and others in sport or society. Natural preferences can be altered by experience. The taste of olives, unpleasant at first, may become quite agreeable in time if one perseveres in eating them. A single experience of becoming nauseated by overeating some favorite food is often sufficient to establish an attitude of aversion toward it. Experiments have shown that the affective value of musical intervals can be modified by training and experience. A person's tastes and aversions undergo radical revisions during the course of

life. The affective value of things is determined by our reactive attitudes toward them, and these reactive attitudes often represent the cumulative product of a great variety of experiences. This dependence of affection upon experience is readily explicable in terms of the judgmental hypothesis. It assumes that the affective tone ascribed to an object is a function of a person's reactive attitude toward it, and naturally these reactive attitudes are to a large extent a matter of habit and hence a product of experience. The sensory and elemental conceptions encounter some difficulty with this fact for they assume that the affective character of a stimulating situation is a function of the pathway traversed by the neural impulse. Any change of affective tone thus involves a definite shift of conduction pathway, and the theories are forced to account for the effectiveness of experience in promoting these shifts.

The duration of an experience modifies its affective tone. Monotony is conducive to unpleasantness, and change and variety to pleasure. An enjoyable strain of music becomes unpleasant when too frequently repeated, and enjoyable foods are disagreeable when eaten to excess. A child will play with a ball for a time and then forsake it for a more pleasant pastime. A pleasant activity thus becomes unpleasant when too long continued and regains its normal affective tone after an interval of rest. Pleasure soon palls when once it is attained. Again the sensory and elemental conceptions encounter serious difficulty in explaining these temporary shifts of conduction pathway with such temporal changes of condition.

It is alleged that the affective tone of an object depends upon the variable circumstances in which it is experienced. A given tone is pleasant when heard as a part of a musical chord and unpleasant as a constituent element of a discord.

The affective character of a given color is a function of the variable background in which it is perceived, or of the color combination of which it is a part. Such statements are fallacious. It is not the tone but the tonal combination that is regarded as pleasant or unpleasant. The affective judgments refer not to the given color but to the color combination of which it is a part. It is also said that all distractive stimuli are necessarily unpleasant, but as previously noted the affective judgments refer primarily to the progress of our work and not to the distractive conditions. Impeded progress in the attainment of a desired end is unpleasant, while progress is regarded with satisfaction. The affective judgments are frequently relative in character. A situation that is usually regarded as unpleasant may be judged to be pleasant as compared with some more unpleasant situation. The monotonous dull ache of a sore tooth may become so unbearable that we may find satisfaction and relief in irritating it. Relief from pain is always pleasant. All of these facts are inconsistent with the attributive theory, and can be most readily explained in terms of the judgmental hypothesis.

It is universally admitted that pleasantness and unpleasantness are experienced only in conjunction with objects to which they bear an attributive relation. Pleasantness and unpleasantness always belong to some object and are never experienced in isolation. According to the sensory and elemental conceptions, the affective items of experience can be aroused only indirectly by means of some sensory stimulus. These theories nicely account for the fact that pleasantness and unpleasantness can be experienced only in conjunction with a sensory object, but they do not readily explain why these affective items are invariably regarded as attributes of the objects that excite

them. The mere conjunction of two experiences is not a sufficient explanation of the fact that one of these is invariably regarded as the attribute of the other. While this difficulty is not an insuperable one, yet the attributive relation between affection and the stimulating object can be more readily accounted for in terms of the attributive and judgmental conceptions.

The four conceptions also raise the question of observational fact. The attributive, sensory, and elemental conceptions assert that pleasantness and unpleasantness are constituent items of experience that can be analytically observed. The judgmental hypothesis denies the existence of these alleged contents; it assumes that pleasantness and unpleasantness are names for the two distinctive *meanings* which objects may acquire in virtue of the type of adaptive response which they normally elicit. The affective aspect of an object is a product of a certain type of cognitive reaction to that object, and it has no existence apart from that reaction; the unpleasantness of an object is not a given characteristic of that object whose existence is subsequently noted and reported. In this connection, we may cite the generally accepted fact that pleasantness and unpleasantness are unlike sensations in that they are not potential objects of attention.

Attention to a sensory object is conducive to its clearness and distinctness, while the affective aspects of experience immediately disappear when we attempt to attend to them. According to the sensory, attributive, and elemental conceptions, there is no valid reason why these affective items can not be attentively examined as readily as can any other content of experience. Moreover, the fact is incompatible with the three theories in so far as they assert that the existence of these alleged contents can be attested by observation

but admit that they tend to disappear when attentively examined. The relation of affection to attention is readily explained by the judgmental hypothesis for it assumes that the pleasantness of an object is a product of a particular mode of cognizing that object. Naturally this affective attribute will immediately disappear when we cease to cognize the object in this manner in the vain attempt to apprehend the pleasure as a separate object of attention. The judgmental conception assumes that the sensory object and the organic reactions that it elicits are the only observable contents that can be detected in the search for an affective element.

The adaptive responses to such stimuli as taste, pain, and smell usually involve a rather diffuse and widespread organic reaction. Holding the breath is the normal avoidance reaction to a disagreeable odor, and this reaction impedes the circulation in the region of the head and neck with a consequent change of sensitivity in these parts. Disagreeable tastes excite the salivary flow and arouse an incipient nausea which in turn influences the breathing and circulation. Pain also induces a very diffuse and pronounced intraorganic reaction, and we may suggest that it is these rather vague organic experiences that are mistaken for an affective element.

Function of Affection. — As previously stated, a situation that is judged to be pleasant normally arouses a positive response, and an object that is regarded as unpleasant normally excites a negative response. Such responses may be inhibited by other motivating conditions, and hence we may actually avoid pleasurable situations and react positively to unpleasant things. But these positive responses to unpleasant things are performed as a means of attaining some desirable and pleasant end, and pleasurable things are avoided in order to attain some other desirable end or

to escape some unpleasant consequences. Pleasure is thus correlated in the long run with positively adaptive responses and unpleasantness with negative ones. This correlation between the affective character of things and the type of response which they normally elicit is an indubitable fact and it demands some sort of explanation.

The attributive, sensory, and elemental conceptions logically imply the assumption that pleasantness and unpleasantness exert some *causal* influence upon the development of all adaptive modes of response. Pleasantness and unpleasantness are regarded as constituent items of a stimulating situation, and naturally their presence or absence should make some difference in the way a person reacts to that situation. For example, the elemental conception assumes that the neural impulse due to a sensory stimulus may or may not pass through the affective centre before emerging into a motor channel, and consequently the character of the response should be affected in some way by such a difference of preceding conditions.

A biological theory of affection assumes that all organisms, prior to experience, guide their conduct in reference to objects on the basis of their affective character. The theory starts with the accepted fact that innate conditions are responsible for the affective character of many sensory stimuli. These innate conditions are products of evolution, and the theory assumes that all evolutionary products necessarily have a survival value. Consequently unpleasant and pleasant objects are respectively detrimental and beneficial to the welfare and survival of the organism. The affective characteristics of an object are thus signs of its value, and it is these signs that enable an organism, prior to experience, to choose that which is good and avoid that which is harmful. The theory ignores the difficulty of ex-

plaining how an organism, prior to experience, can know the meaning of these signs or react to an object on the basis of this knowledge. Furthermore, the concept of natural selection does not justify the assumption that all products of evolution are necessarily useful for the preservation of life (p. 371).

A popular doctrine called *hedonism* asserts that pleasantness and unpleasantness constitute the ultimate goals of conduct, that all acts are governed by affective considerations, and that organisms are so constituted that they invariably seek pleasure and avoid unpleasantness. The doctrine does not assert that sensory stimuli that are lacking in affective tone are incapable of arousing any reaction, but that they are powerless in and of themselves to elicit any *adaptive* response. It is the affective characteristic of an object that is responsible for our positive or negative reaction toward it. The doctrine asserts that we eat and drink for the pleasures involved and not to alleviate hunger or quench our thirst, that a child withdraws its hand from the fire not because of the pain but because of its disagreeableness, that a person listens to a faint sound for the sake of pleasure and not to hear it better, and that the pupil expands in the dark to avoid a disagreeable situation and not to admit more light. It is the pleasant or unpleasant aspect of an object that is primarily responsible for the *way* we react toward it. Without affection, an organism will respond to the world in some fashion but will be incapable of reacting to it in any adaptive manner. As a theory of conduct, this doctrine fails to withstand the test of a rigorous analysis.

According to a final view, the affective aspects of experience do not determine the character of the responses that are elicited by problematical situations but rather they

are responsible for the fixation of those that are successful and for the elimination of those that are unsuccessful. The correct or successful act is selected because it gives pleasure, and the wrong or unsuccessful acts are eliminated because of their unpleasantness (p. 93). Pleasure is said to 'stamp in' a successful act, while unpleasantness is supposed to weaken those that are unsuccessful. Pleasantness and unpleasantness thus play a decisive rôle in the development and establishment of every adaptive act. This doctrine is subject to attack on factual grounds, for it assumes that all wrong acts are necessarily unpleasant. It is rather ridiculous to assert that a person is displeased at every incursion into a blind alley in mastering a stylus maze, that a small boy feels a twinge of unpleasantness with every imperfect stroke in learning to swim, and that a babe is displeased with every slip in learning to walk. In learning a stylus maze, for example, it has been found that wrong acts are frequently made and eliminated without the subject ever being aware of the fact.

The judgmental conception accounts for the correlation of affection and adaptive responses in an entirely different manner. Objects are judged to be pleasant or unpleasant because of our knowledge of the type of adaptive response which they elicit when our reaction to them is uncomplicated by extraneous considerations, and these normal or typical adaptive responses to objects are a function of our instinctive or habitual organization in reference to them. The affective characteristics of objects are thus the product, rather than the cause, of our normal reactive tendencies toward them. We do not originally avoid an object because it is unpleasant; rather that object possesses its unpleasant character in virtue of the fact that it previously elicited a negative reaction.

Pleasantness and unpleasantness can thus be assigned no function in the initial establishment of adaptive responses. According to the judgmental conception, we must state the function of affection in terms of the value or utility of classifying and characterizing objects in respect to the type of adaptive response which they normally elicit, and we may say that these modes of characterizing objects have exactly the same value as any other form of knowledge, *viz.*, its use in the subsequent guidance of conduct. For example, a child is given a dose of bitter medicine which arouses a violent negative reaction, and a few repetitions of this experience are sufficient to establish an effective association between this negative reaction and the sight of the bottle. As a consequence of this association, the medicine is *visually* perceived as something disagreeable, and the child thereafter reacts to the sight of the bottle in accordance with this knowledge.

Affection and Evaluation. — Experiences are constantly being evaluated from the standpoint of their *human* worth. This type of evaluation also finds its genetic origin in the spontaneous adaptive tendencies of the organism. Judgments of value are thus genetically correlated with the affective and conative judgments. Pleasing and desirable things are also regarded as good and valuable things *per se,* while the displeasing and undesirable things are regarded with disapproval. In so far as these judgments of value are uncomplicated by ulterior motives, the child will identify pleasure with goodness and characterize unpleasant things as bad. The affective, conative, and evaluating judgments are not causally related, however, for they have a common origin in the reactive tendencies of the organism.

These primitive judgments of value are not necessarily

valid as is assumed by the evolutionary theory of affection (p. 300). As a matter of fact, they are constantly being revised with the growth of experience, and as a consequence the adult mind does not invariably regard pleasant and unpleasant things as good and bad respectively. Our developed system of human values is to a large extent a product of many other factors.

The development of our ethical and moral judgments — judgments of good and bad, and right and wrong — is profoundly influenced by the *social consequences* of our acts. In so far as a person's conduct affects other people, it is capable of being evaluated from two distinct points of view — that of the person who performs the act and that of those who may be affected by that act. Obviously the same act may be differently regarded from the two points of view. A boy who cheats or plays unfairly is likely to take a different attitude toward his actions from that of his companions. As we have indicated, the egocentric attitude is the primary one. The small child is naturally not disposed to regard his own actions with disapprobation. What he likes to do is usually regarded as eminently right and proper, and it is the acts of others which displease him that are regarded with disapproval. The adult comes to adopt a more impersonal and social attitude in his ethical judgments. He is more inclined to evaluate his own acts from the standpoint of others, in terms of their wider social significance, and this transition from an individualistic to a more *social* ethical standard is due to the influence of numerous factors operative throughout our mental and social development.

Necessarily many acts must be experienced and evaluated from both points of view. The same individual may both cheat and be cheated, and the young bully may in

turn be bullied by a larger companion. Sympathy and love for others, and the desire to placate and win the approval of our fellows also constrain us to envisage our acts from their point of view. For numerous reasons we all become members of various social groups, and naturally come to identify to some extent the welfare of those groups with that of our own. In other words, we develop a *social* personality, and as a consequence begin to evaluate all acts more and more from the standpoint of our wider social self-interest, — from the standpoint of the groups to which we belong. In the process of mental and social development, each individual enters into and identifies himself with larger and more inclusive social groups such as the home, the church, the school, a professional or economic group, the community, the state, the nation, and his racial group. Beginning with an egocentric attitude, each developing individual is forced to keep continually revising his ethical values from the standpoint of a more inclusive group, until the ideal is finally attained of judging all things from the standpoint of the welfare of humanity as a whole. We are not born with any intuitive knowledge of right and wrong. Each individual's ethical conceptions are gradually acquired during life, while the ethical standards of any race are the products of its racial development.

Our primitive judgments about things are also revised in terms of their ultimate personal consequences. Because of a lack of knowledge, a child must necessarily base his value of things wholly on their *immediate* character. Things whose taste a child likes, he terms good and eats with no thought of their possible consequences. Naturally a person can evaluate things in terms of their later effects only in so far as these effects are known and duly appreciated. Such an evaluation involves a knowledge of

causal relationships which presupposes a considerable amount of mental development. We all come to appreciate the personal consequences of such things as dishonesty, disobedience, laziness, crime, and vice and sensuousness, but even yet we have much to learn concerning the laws of mental and physical hygiene and rarely do we appreciate the full extent to which our mental, moral, and physical characteristics are a product of our experiences during the formative period of childhood (p. 341). The human worth of many types of experience is still capable of a considerable revision in terms of their ultimate significance.

Many desires, types of experience, and traits of character are mutually exclusive and incompatible with each other. No person can realize all of the possibilities of his nature. One can not be both lazy and energetic, avaricious and philanthropic, candid and deceitful, vulgar and refined, sensuous and intellectual, or a successful surgeon and a captain of industry. Each individual is being continually confronted with alternatives between which he must pick and choose. Values to a considerable extent are *relative*. Things must be evaluated not only on their own account but also in terms of their possible alternatives. It thus follows that many pleasing and desirable things which would naturally be termed good are finally judged to be bad and unworthy simply because they interfere with the realization of some more desirable end. It was a perverted sense of relative values that induced the ascetics of the Middle Ages to deny and mortify the flesh in the interest of spiritual values.

A person's system of values is also influenced by the *opinions and attitudes of others*. No developing personality ever works out his own system of values independently of the opinions of the social group to which he belongs. Such

agencies as the home, school, and church attempt to imbue the child with the accepted standards of society. They inculcate certain notions of personal and social hygiene, teach him what is right and wrong, and attempt to mold his tastes in the realm of literature and art. The child's attitude toward life is also influenced by the expressed opinions of his companions and by the example of those whom he likes and admires. Our susceptibility to social standards is further illustrated by our attitudes in the realm of art. We sometimes call things good not because we like them but in order to conform our judgments to the accepted standards of æsthetic values. We are all somewhat inclined to give fulsome praise to the literary classics and patronize opera and symphony concerts and yet read trash and indulge in jazz and musical comedy.

Evaluation, as stated in the Introductory Chapter (p. 3), is a type of mental activity of considerable importance. It is the process by means of which things become appraised as to their worth as goals of human conduct, the process of formulating notions as to the relative desirability of things from the standpoint of a person's life as a whole and the welfare of the social groups to which he belongs. Systematic knowledge of this sort develops from experience and finds its value in the influence it exerts in the regulation and control of subsequent conduct. It is ideals and systems of value that stabilize human character and measure the strength and worth of any civilization.

EXERCISES

1. List the various conditions that might alter temporarily your affective attitude toward a favorite melody. What ones might exert a permanent effect upon your attitude? Give an illustration of each condition.

2. List the various conditions that may exert a permanent effect upon your affective attitude toward a certain food. Illustrate each.

3. List any considerations other than those given in the text that you deem significant in making a decision as to the relative merits of the four conceptions of affection.

4. Reread the topic of Fixation in Chapter V. What facts induced the author to reject the doctrine that acts are fixated or eliminated in virtue of their affective consequences? What facts can you adduce in support of the doctrine?

5. List the arguments pro and con the doctrine of Hedonism.

6. Do you think there is any relation between our affective attitudes and our aesthetic judgments? Between our affective attitudes and our notions of right and wrong? How would you account for these relations?

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CHAPTER XIV

VOLITION

From the standpoint of volition, acts may be classified as voluntary, involuntary, and automatic. Voluntary acts are those which are due to will. Involuntary acts are those which occur in spite of our volitional intentions as when we unsuccessfully attempt to prevent a sneeze or a yawn. Volition is absent in an automatic act, and hence the nature of volition may be ascertained by a comparative analysis of these three types of activity.

Voluntary Activity. — Voluntary activity is that which is performed in accordance with a person's wants, desires, and wishes; it is purposeful and intentional action. Such terms imply a knowledge of some prospective condition and a reaction in reference to that condition on the basis of this knowledge. Voluntary acts are those which are influenced in any manner by a knowledge of their adaptive significance in relation to some prospective situation. A voluntary act involves a knowledge of some end to be attained or avoided, and a reaction in reference to that end on the basis of this knowledge. Volition may thus be defined as the intellectual control of activity, the influence which is exerted upon an act by any anticipatory knowledge of its desirable or undesirable consequences.

Involuntary Activity. — Involuntary acts are similar to voluntary in every respect with the exception that the intellectual factor is powerless to affect or inhibit the activity.

One starts to sneeze and anticipates some undesirable consequence, but the stimulating or dynamic strength of this cognitive process is insufficient to more than check the act for a moment and it is finally consummated in spite of the inhibitory tendency to the contrary. Involuntary acts are performed in spite of one's wishes, purposes, and intentions; they involve a conflict between an act and the cognitive or volitional process with a final resolution in favor of the former. In voluntary activity the intellectual factor is effective or successful in modifying the act, while an involuntary activity represents an unsuccessful act of will.

Automatic Activity. — Purpose and intention are absent in automatic acts. The act is frequently initiated and completed without any cognitive appreciation of its prospective significance. Prevision is absent because of preoccupation with other tasks or because the act is performed too quickly as in the case of such impulsive responses as the start of surprise to a sudden noise and the withdrawal of the hand from a painful stimulus. The act is *first* performed, and any knowledge or appraisal of the act in relation to its consequences is necessarily retrospective. Obviously, the course of an activity can not be influenced by its *subsequent* appraisal. Without prevision, no volitional influence is possible. Prevision of consequences may be present, however, and the act be automatic provided these consequences are valueless and hence exert no effect upon the act. Reverie is a typical example. We sit down for a period of relaxation and allow our mind to wander whither it will. We are keenly aware of the train of thought and are able to anticipate to some extent the probable drift of our mind, but for the present we are totally unconcerned as to what happens, and sit idly by as a passive observer and make no attempt to interrupt or

control the course of our thoughts. Prevision of some desirable or undesirable goal and an appraisal of the act in relation to this goal are thus essential to volition. Moreover, the intellectual factor must be of such a character that it exerts some *appreciable* influence upon the outcome of the act in order that the process may be termed volitional.

The Concept of Will. — Will may be defined as the intellectual control and supervision of activity in relation to some approved or undesirable end. Volition is a process which enables organisms to adapt to prospective conditions, — to attain desirable ends and avoid those which are undesirable. Will involves a knowledge of an end and the utilization of this knowledge in reacting to that end. Will represents the dynamic aspect of a cognitive process in promoting conduct adapted to some anticipated condition or situation. As previously developed (p. 183), all cognitive processes have a dual aspect; they give us knowledge of objects, and function as stimuli in determining the subsequent course of our activity. Two factors are thus involved in will, — knowledge of a prospective condition, and the stimulating influence of this knowledge in arousing a response adapted to that condition. Will may thus be defined as the dynamic effect which a knowledge of prospective conditions exerts in promoting responses adapted to those conditions.

Will is thus not some mysterious, unconscious, or supernatural force which is the cause of all our actions. Organisms are active, not because of will, but because they are born alive in a world in which they are subjected to continual sensory stimulation (p. 72). Automatic action of some sort necessarily precedes will, for will involves knowledge of prospective conditions, and such knowledge is derived from previous experience. The term will refers to the

cognitive regulation and control of action rather than to its initiation.

Contrary to the opinions of some authors, the cognitive process involved in will may be a percept as well as an idea. A person reaches for an apple and before the act is completed observes that the hand is wrongly directed. The act is thus perceptually appraised in relation to its goal. The subject is cognizant of the prospective results of the uncompleted act, and the movement is redirected on the basis of this perceptual knowledge. Obviously this guidance of the act on the basis of a knowledge of its consequences must be termed an act of will.

Any type of activity may be subject to volitional supervision. The exercise of will is not limited to the control of overt movements. A person may voluntarily attend to an object, recall a forgotten name, commit a poem to memory, imagine a novel object, listen to a conversation, perceptually scan the horizon, write a letter, practice at the piano, plan and construct a house, and make a choice of a profession. Reasoning (p. 189) may now be defined as *volitional* or purposive thinking. Even the intraorganic activities are to some extent subject to voluntary control, for it is possible to arouse and perpetuate a mood and voluntarily inhibit the rise of an emotion. It is usually asserted that the action of the heart and the digestive operations are automatic activities and hence are not subject to volitional influences. Such activities are automatic for the most part, but nevertheless they are subject to some degree of volitional control.

If I wish to make my heart beat faster, I can readily do so by indulging in vigorous exercise, and I can likewise disturb or promote the digestive operations by engaging in strenuous work or lying down for a rest after a hearty

meal. It may be objected that such control is not volitional because of its indirect and circuitous character. The objection, however, is not valid, for all volitional control is *indirect*. As we have seen, the voluntary control of any act is always exercised through the medium of an *associated* intellectual process. It is hardly feasible to classify control on the basis of its degree of indirectness, and it may be doubted if the intentional acceleration of the heartbeat through the medium of exercise is a whit more indirect than is the voluntary revival of a forgotten name by means of some remote associations. For example, I wish to recall the name of some college associate whom I have neither seen nor thought of for a number of years, and I finally achieve my purpose by reinstating the names of as many of our classmates as possible, by reviving the various events in which we both participated, and by running over the alphabet and trying out various letter combinations in the hope that one will suggest the name in question.

All volitional activities are partly automatic in character. Very rarely is an act volitionally supervised throughout the entire course of its performance. All well organized and complicated activities such as talking, walking, reading, and playing the piano contain many parts that function in a purely automatic fashion, and only the occasional intervention of voluntary control is requisite for their successful performance. Voluntary acts are usually defined as those which are subject to any degree of volitional influence. On the basis of this definition, the great majority of human actions must be regarded as voluntary.

Volition may influence an act in various ways. The act may be voluntarily initiated and then be automatically completed. The finger run of a pianist may be cited as an example. Volition may also be exerted at any time during

the performance of an act. The volitional influence may be limited to the mere approval and continuance of the act, or the activity may be inhibited, or purposefully abandoned in the interest of some other line of activity. The volitional influence may be exerted from time to time to modify or redirect the act in reference to its goal, to eliminate distractive influences, and to keep our mind on a given task until it is completed. Volition may merely accelerate an act as when we hasten our steps to catch a train, or it may spur us on to more persistent and aggressive endeavors when we begin to tire, or interest lags, or unexpected difficulties are encountered. Will may also be employed in the resolution of conflicts, — the choice between alternate courses of action, the choice of a profession, a place to spend our vacation, or ways of spending and investing our meagre income. Life is continually presenting various possibilities of action, only one of which can be realized at a time, and any selection based upon a cognitive analysis of the relative merits of these possibilities is termed a voluntary choice or decision. The term 'volitional control' of activity may thus be defined as any initiating, inhibiting, directing, energizing, or selective influence that is exerted in the interest of attaining some end or of avoiding those things which we dislike.

People differ in many ways as to their volitional characteristics, and these differences may be conveniently discussed under two general headings, — intellectual characteristics and differences of will power.

Intellectual Differences. — People differ very materially as to their knowledge of the potential consequences of acts, — as to the amount of knowledge they possess which can be utilized for the purpose of regulating and directing their conduct. Many individuals act as they do simply because

of ignorance of consequences. People often drift into some profession, trade, or occupation because of an inadequate knowledge of vocational opportunities. It is now generally recognized that crime, vice, and disease are to a considerable extent the products of ignorance. Undesirable habits and traits of character are permitted to develop and remain uncorrected because we fail to appreciate their significance. Bad habits of personal hygiene often reflect a lack of knowledge. The apathy of the public towards social and industrial reforms is to some extent due to defective knowledge of conditions or to lack of appreciation of their significance. The widespread dissemination of knowledge concerning actual conditions constitutes the first step requisite to the public adoption of measures designed to improve sanitation, prevent vice, and remedy political and industrial abuses. Knowledge and understanding are essential to any permanent and thorough-going reformation.

Objects are always evaluated in terms of their worth as ends or goals of action, — as things to be attained, ignored, or avoided (p. 303), and it is this aspect of knowledge that is most significant from the standpoint of volition. Consequences of acts and anticipated conditions will regulate and incite action in accordance with our notion of their value. People differ considerably as to their judgments of relative value, and this fact explains why two people frequently make different decisions on the basis of the same group of data. Considerations that appeal very strongly to one person will exert but little influence upon another, and vice versa.

The volitional effectiveness of knowledge depends upon the nature of its associations (p. 184), and these vary with the method of its acquisition and the way it has previously been used. Knowledge will arouse a given action

only in so far as it has some associative connection with that act, and it is for this reason that any knowledge gained through practical experience is usually more effective than that obtained through instruction. For example, if a child burns its fingers in playing with fire, it is much more likely to use this knowledge in the subsequent regulation of its conduct than if this information concerning the effects of fire had been obtained from parents or books. Knowledge gained through the performance of an act will naturally become directly associated with that act.

The assumption of self-responsibility for acts is essential to volitional effectiveness. Some people are much given to evading and disclaiming all responsibility for the results of their actions. Children are naturally somewhat inclined to make excuses for their wrongdoing by saying that they forgot, that the act was accidental or unintentional, or that their act was the fault of others. An unwise attitude on the part of indulgent parents is often responsible for the further development of this tendency. Some parents are prone to condone the faults and failings of their children and to take their part in all their difficulties with playmates and teachers. Unwise modes of punishment may also foster this attitude of mind. The observant child notes that the infraction of certain regulations does not invariably incur censure or punishment. Some pupils are punished and others are not, or the teacher may be quite irritable and vindictive on one occasion and good-natured and lenient on another, and the child naturally concludes that his punishment is due to the prejudice or whim of the teacher, rather than regarding it as the consequence of his transgression. Such punishment merely breeds resentment and discontent. Punishment must invariably follow the act in order to be regarded as its consequent, and a belief in

such a causal relation is essential to volitional responsibility and self-control. This habit of disclaiming responsibility is characteristic of many criminals and ne'er-do-wells, who assert that they never had a fair chance, that their home training was defective, that they were led astray by evil companions, and that in general the world has been against them. Delusions of persecution among the insane represent the same attitude of mind. Such an attitude is fatal to all progress and self-development, for it is useless to work and struggle and attempt to do better if our success or failure in the world is not due to our own efforts. Such a fatalistic attitude of mind merely excites one's pity or contempt. Acceptance of responsibility is essential to volitional effectiveness. It is the person who cheerfully accepts whatever comes without excuse or complaint that awakens our admiration and respect.

People differ in the extent to which they utilize their knowledge in volitional situations. There is the thoughtless, heedless, hasty and impulsive individual who acts without due consideration of consequences, as opposed to the extremely cautious, farseeing, and deliberative type of person who carefully weighs all possibilities before adopting a course of action. Some people act thoughtlessly through sheer mental inertia or lack of initiative; they are too lazy or careless to take the time or trouble to think. Others can readily think in abstract and impersonal terms, but are unable to apply this knowledge to the regulation of their own conduct. Such people are familiar with ethical and social standards and thoroughly conversant with the consequences of right and wrong actions, and they can readily think of such things in abstract terms or in connection with the acts of others, but for some reason they have failed to establish any effective association between this

knowledge and their own conduct. The impulsive individual is disposed to quick decisions and immediate action. He is too impatient to wait and consider consequences before acting. He is of the type that acts first and thinks afterwards. An impulsive disposition is to some extent a matter of temperament but it may be fostered by circumstances. There are many conditions of life which demand quick decisions and prompt action. The heedless individual is wholly unconcerned about the possible consequences of his acts because of his supreme confidence in his ability to extricate himself successfully from any unexpected difficulties that may develop. His previous success in life has fostered a disposition to act blindly and trust to luck and his own ability to meet each new situation as it arises. The heedless individual does not believe in crossing his bridges before reaching them. Some people never face issues squarely and give due consideration to both the favorable and unfavorable aspects of a contemplated course of action. The mind of the pessimist is prone to dwell upon and emphasize the possible difficulties to be encountered and the likelihood of failure. The cheerful optimist on the other hand ignores difficulties and thinks only of those circumstances which are favorable to success. Such differences are partly a matter of temperament but to a large extent are due to habits of thought which have been fostered by circumstances.

Some minds are too cautious and deliberative for effective action. Such individuals find difficulty in reaching a final decision. They are hesitant to act because they are mistrustful, cautious, and fearful of making a mistake. They keep continually recanvassing a given situation, postponing the time for action, and revising their decisions at every opportunity. They lack self-reliance and confidence in their

own ability. This aversion to making a final decision and acting promptly in accordance with it may manifest itself when dealing with more or less trivial affairs. Many circumstances of life permit and encourage the development of such a pernicious habit. Such an aversion may develop to such a strength as to become a mania. An effective will represents a proper balance between the impulsive and deliberative types of mind. A person should cultivate the habit of examining thoroughly every aspect of a situation, making a prompt decision, and acting in accordance with that decision as soon as practicable.

Will Power. — In the ordinary run of events, volitional stimuli are sufficiently dynamic to induce an appropriate response. We think of some desirable end and react at once to attain it; we consider the various possibilities of some course of action, make a decision, and act accordingly. For the most part the effectiveness of will demands no explanation.

Many situations arise, however, in which these volitional stimuli are ineffective, — in which we are unable to achieve our intentions and act in accordance with our decisions. Certain of our intentions require a considerable amount of time and effort for their realization, and we lack the requisite energy, stamina, and perseverance to keep going until the end is attained. We also encounter unexpected difficulties in the way of material obstacles, distracting conditions, the opposition of our fellows, etc., and we lack the requisite energy and determination to continue our volitional efforts in the face of such adverse circumstances. Volitional decisions are also ineffective because they run counter to some long established habit of action. We decide to quit smoking, be less selfish, less given to anger and resentment, more respectful and

obedient to our parents, more diligent and industrious in our work, and more charitable to the frailties of our neighbors, but we keep relapsing to our evil ways in spite of our good intentions, and finally give up the task of reformation as hopeless. The ineffectiveness of any volitional stimulus is to be explained primarily in terms of the inhibitory effect of some stronger and more dominant activity.

People differ very materially in their ability to keep their minds on a given task and carry out their intentions and intellectual decisions in the face of adverse circumstances. Some minds are easily distracted and swerved from their purposes, easily discouraged by failure or difficulty, and readily inclined to yield to the impulse of the moment. Others are more set and resolute in their purposes, and manifest greater perseverance, aggressiveness, and determination in their attempts to achieve those ends. Such variable traits are usually termed differences in *will power*. A person of strong will power is one whose mind dominates his actions, — one who can keep his mind on a chosen task in spite of distractions, and who has the requisite energy, knowledge, and dogged determination to carry out whatever decisions he may make.

Will power is a product of many factors. Perseverance is partly dependent upon constitutional conditions such as health and organic vigor. Animals differ considerably as to the energy and persistence with which they will attack a given problem (p. 91). Some infants are more persistent than others in satisfying their wants. Some children are naturally stubborn, it is said, but stubbornness merely represents an unusual degree of perseverance in attaining ends not approved by others; it is a type of perseverance which is not susceptible to social influences. Perseverance

may be strengthened by success. As every parent knows, it takes the small infant but a short time to learn the value of persistence in having its own way. With mental development, volitional success may become a matter of personal pride, and this factor then operates as a continual spur to our volitional endeavors. Society puts a premium upon such traits as perseverance, determination, and strength of will, and this knowledge of the attitude of our fellows functions as an additional incentive to volitional success. It is for this reason that any public declaration of our purposes and intentions stimulates us to achieve them, for any failure to do so under these circumstances constitutes either an indictment of our sincerity or a reflection on our strength of character. Strength of will and tenacity of purpose may also be weakened as well as strengthened by various circumstances, and it is no uncommon occurrence for the public recognition of some signal defeat practically to crush the indomitable spirit of one long accustomed to rule with an iron hand.

A vigorous and lively imagination is popularly regarded as a volitional asset. The stimulating efficiency of an object of thought varies with its mode of representation (p. 132). A vivid and detailed imaginal representation of an object is much more likely to elicit a vigorous appropriate response than will that same object when thought of in a more symbolic and schematic manner. Orators are accustomed to appeal to the imagination in order to sway their audiences. In olden days many a hardened sinner was brought to repentance by a vivid portrayal of the torments of hell. Persons whose minds are accustomed to apprehend a prospective situation in a vivid and comprehensive manner are the ones who are the most likely to react to that situation with some degree of vigor and determination.

Volitional effectiveness is dependent upon environmental conditions. Some environmental conditions exert a distractive and inhibitory effect upon a person's volitional efforts, while others are stimulating and suggestive in nature. A person engaged in study can not do effective work amidst noisy surroundings or in a room with inadequate heat, light, and ventilation. A student expecting to do excellent work in college can not afford to associate with confirmed idlers. A drunkard or thief will find it difficult to mend his ways and still frequent his old haunts and associate with evil companions. A radical change of environment is usually requisite to any permanent and thorough reformation. Temptations must be avoided as far as possible until the new mental attitude is firmly established. A suggestive environment, on the other hand, exerts a favorable influence upon one's ability to keep his mind upon a given task, while one's resolution and determination to achieve a given end may be materially strengthened by the choice of proper associates. It is thus evident that volitional success may be promoted in various ways through the proper regulation of environmental relationships.

Volitional effectiveness is also a function of various intraorganic conditions such as health, vigor, fatigue, bodily postures, etc. A person can not readily keep his mind upon a task and do his best work while in an uncomfortable position, when fatigued, while hungry, nervous, and irritable, or while suffering from a headache. Volitional efficiency can thus be indirectly promoted by the maintenance of bodily health and by keeping the mind in a fresh and alert condition.

The ability to meet a volitional situation can be promoted by the arousal of appropriate motor attitudes. A

person usually prepares himself to meet the shock of expected pain by a vigorous and sustained contracture of all the muscles of the body. The natural response to a given stimulus can be more readily prevented by the prior arousal of some antagonistic reaction. Activities are mutually inhibitory, and any dominant ongoing activity naturally renders the organism less susceptible to those stimuli that normally elicit some other type of response (p. 37). Motor attitudes may also serve as suggestive reminders of a volitional task. Ideas are highly instable activities, and the continual recurrence of a given topic of thought is due to its association with some persistent group of sensory stimuli. As indicated in a previous paragraph, the continuity of thought is due in a large measure to the stable character of the objective environment. Intraorganic stimuli may also serve the same purpose. A person naturally encounters but little difficulty in occupying his mind with thoughts of foods as long as he is hungry. The afferent sensitivity of a muscular response may serve to reëxcite that act, and in this way any motor attitude may become so organized as to sustain itself automatically for a considerable period of time.

Certain bodily attitudes and facial strains are usually involved in any serious reflective effort, and the persistent presence of these attitudes serves as a continual reminder of the task in hand. It is thus possible to control the course of thought to some extent through the establishment of an appropriate motor attitude. The resultant stimulus from a muscular contraction may also energize some other concomitant activity. The volitional energy requisite for some supreme effort of will may thus be obtained through the vigorous contraction of an accessory group of muscles. The tiring runner is wont to contract all the muscles of the

arms and face in order to arouse himself to a final burst of speed. The popular notion that a grim face and a set jaw are indicative of a resolute and determined mind is not wholly without justification. By the appropriate use of such attitudes, a person can steel himself to resist temptation and meet the shock of expected pain or sorrow, or prepare himself to react to a given situation with a greater degree of vigor and determination.

When properly organized, the emotions are a source of volitional energy. As previously stated (Chap. XII), certain emotions represent intraorganic readjustments which are conducive to particular types of response. Granted the truth of this doctrine, it is evident that the arousal of an emotion appropriate to a given volitional situation will enable a person to react to that situation with a greater degree of effectiveness. Orators are accustomed to appeal to the emotions of their auditors in order to sway their decisions and arouse them to some given line of action, and this use of the emotions may be regarded as a sufficient proof of their utility. With the establishment of the proper associations, each individual is capable of arousing his own emotions and thus utilizing these reserves of energy in the interest of more effective action. Volitional effectiveness implies a strong emotional life rigidly subjected to intellectual control. Vigor, energy, aggressiveness, and determination are not the characteristic traits of the colorless and unemotional person. Lack of control is also fatal to volitional success. The man of strong will power is neither the meek person who is incapable of wrath nor the explosive individual who flies into a rage upon the least provocation.

As is well known, any expression of the emotions exerts an effect upon the attitudes and actions of our fellows, and

consequently with the establishment of intellectual control the emotions may be effectively utilized in the attainment of socials ends. Actors and orators are accustomed to use them for this purpose. With intellectual control, the arousal or repression of the emotions is dependent upon intellectual considerations; a person will get mad only when he deems that the situation demands it, and will refrain from anger when he thinks that its arousal will jeopardize his chances for success. Under these conditions, it is obvious that the emotions can be utilized as an effective means for the attainment of intellectual ends. The subjection of the emotions to intellectual control is not something that can be obtained by the mere expression of our desire for it. The arousal of an emotion as a response to an intellectual stimulus presupposes some associative connection between them. An appropriate system of associations is thus essential to control, and time, effort, and judgment are requisite for the development of such a system of habits.

The stimulating efficiency of any purpose, intention, or desire may be readily enhanced by a process of ideational reinforcement, — by the arousal of other ideas which function as additional incentives in arousing the desired response. It is a relatively easy matter for any ingenious person to discover all sorts of additional reasons to justify some contemplated course of action, and we are all accustomed to use this method to pluck up courage and strengthen our wavering resolution in order to attain some desirable but not wholly justifiable end. Many a man has induced himself to purchase a pleasure car by appealing to various subsidiary incentives as a justification of his actions.

This process may also be employed to control the ac-

tions of others, and this fact accounts in large part for the so-called ' miracles of conversion,' or the sudden transformation of long established habits of action. No one is wholly good or bad. Even the most hardened sinner has much that is good within him. No one can avoid acquiring many impressions and coming into contact with various influences that make for righteousness. Such agencies as the home, the school, the press, and the church must inevitably bring one into contact with and develop some sort of respect for the social ideals of the time. Love for one's children and the desire for the sympathy, respect, and companionship of one's fellows will necessarily foster some sense of obligation and respect for the rights and feelings of others. No great amount of intelligence is required for an appreciation of the fact that a virtuous life can be justified on the basis of an enlightened self-interest. Neither is the moral reprobate wholly satisfied with every aspect of his life of sin, and as a consequence he has his periods of regret and remorse for the past, with vague yearnings and half-hearted resolutions for a better life to come.

It is at these periods of emotional depression that the skillful evangelist is able to effect a moral transformation by reviving all of these dormant tendencies and welding them into an effective stimulus for righteous action. Such types of reformation, however, are not a whit more striking or miraculous in character than are the many cases of a sudden lapse and rapid deterioration on the part of those who have hitherto led wholly exemplary lives. The truth is that we all possess to some extent a dual nature, and the combination of a number of apparently trivial circumstances is often sufficient to determine which of these two aspects of our nature shall predominate.

The sources of will power are thus to be found within our own being. Strength of will involves such factors as bodily vigor, a wide experience of life, the establishment of appropriate traits and habits of thought and action, the proper coördination of mind and body, and an effective knowledge of the various possibilities of self-determination. A person of strong will power is one who is able to utilize all the resources of his being for the attainment of intellectual ends.

Free Will and Determinism. — The doctrine of determinism assumes that every aspect of mental life can be wholly accounted for in terms of cause and effect. It assumes that each mental event is the inevitable consequence of a distinctive set of causal influences, and that each group of causal factors can produce but one effect. According to this view, the character of any human personality must be regarded as the inevitable product of two sets of causal conditions, — the nature of his inheritance, and the various extraneous influences to which he is subjected throughout life. This deterministic conception of mental life is a necessary postulate of any psychology that pretends to be a science. The practical concern of every science is the prediction and control of the phenomena with which it deals, but this prediction and control of any phenomenon is possible only in virtue of our knowledge of its causal relationships. Science is thus primarily engaged in a search for causal relations, and obviously such efforts presume a prior belief in the existence of those relations. Psychology as a science must necessarily proceed upon the assumption that all phases of mental life can be reduced to mechanistic terms, while any psychologist ceases to be a scientist in so far as he admits that any of his data are not amenable to a causal treatment. This

mechanistic conception must not be regarded in the light of an established truth, but it is not a *mere* assumption, for its validity has been justified to the extent to which the complex facts of mental life have already been reduced to a semblance of law and order.

Most people believe in free will in the sense of being able to do as they please, — of having the ability to perform any one of a number of specified acts, or to modify, postpone, inhibit, or perform a given act in accordance with the dictates of their will. This belief is so widespread and apparently so well justified by both fact and common sense that its validity would seem to be beyond question. The existence of free will, however, has been both affirmed and denied, and this fact suggests that the term needs to be carefully defined before any final decision in the matter is possible.

Freedom in its negative aspect implies the partial absence of limiting or restraining conditions. Free will and determinism are thus related concepts, but the nature of this relation can be interpreted in either of two ways. Freedom may be defined as the absence of complete determination, or as the absence of any exclusive determination on the part of some particular group of conditions. The first conception is that of *non-determinism,* while the latter alternative permits free will to be conceived in terms of *self-determination,* or as a form of *spiritual control.*

According to the non-deterministic conception, free will is synonymous with caprice. Adherents of this view assert that man's actions are not completely determined, that mental life can not be wholly accounted for in terms of cause and effect, but that mental events to some extent just happen without any rhyme or reason. It is maintained that all mental operations exhibit a certain capricious and

wholly unpredictable aspect, and that it is this fact which justifies our belief in the freedom of the will.

There are those who adopt the non-deterministic conception of freedom, but deny the existence of free will. Writers of this sort are accustomed to sketch a dreary picture of the human organism as an insignificant atom set adrift in a sea of cosmic forces, with no more initiative, spontaneity, or freedom of action than that exhibited by a chip of wood borne along by the currents of a mighty river. The popular belief in the existence of free will is regarded as a sheer delusion.

The spiritualistic conception assumes that human actions are not wholly determined by natural forces, but that in times of moral stress and conflict each human mind comes into contact with some supernatural or spiritual agency which presumably exerts a determinative influence in the interest of righteous action. This conception defines freedom as any immunity from the domination of *natural forces,* and hence man is free from such dominance in so far as his actions are regulated by any supernatural agency. Freedom is thus a by-product of determinism. Religious and ethical motives were largely responsible for the formulation of this conception as an explanation of man's freedom from the predominating influence of the baser aspects and evil tendencies of his inherited nature. Divine guidance is postulated to account for man's spiritual insight and moral development.

The concept of self-determination defines freedom as independence of environmental conditions, and in this sense man is free just in so far as his actions are determined by conditions inherent in his own nature. Freedom again presupposes the existence of determinism. Self-determination frees man from the dominance of environ-

mental conditions and to this extent makes him master of his own fate.

The relative merits of these conceptions must be considered from two distinct points of view.

The first question is one of alleged fact. Are acts to some extent undetermined? Are human actions susceptible to spiritualistic influences? Are actions to some extent determined by the nature of the organism? The last question must be answered in the affirmative, for every one admits that the nature of any personality is partly responsible for the character of its actions. In the nature of the case, the validity of the first two conceptions can not be submitted to an empirical test. Any answer to such questions will naturally be determined by a person's scientific, religious, and philosophical predilections in the matter. Any answer to such questions is purely a matter of personal opinion, and one man's opinion is but little better than that of another. From the standpoint of alleged fact, the three conceptions are not mutually exclusive, for one can give an affirmative answer to all three questions without being guilty of inconsistency.

The second question is one of terminology. Which conception shall be adopted? Which of the three suggested meanings for the term free will is the correct and proper one? In matters of terminology, it is obvious that conventional usage is the only norm of correctness. In other words, does the popular conception of free will denote caprice, supernatural supervision, or self-determination? As has been indicated, the popular conception is concerned with the problem of man's ability to control and regulate his actions in accordance with his whims and intellectual decisions in the matter; it raises the question as to whether such mental factors as purposes, intentions, cognitive de-

sires, and intellectual decisions can be regarded as effective determinants of action. In other words, the term free will as popularly conceived signifies cognitive self-determination. As previously stated (p. 311), the cognitive apprehension of any desirable or undesirable end is to be regarded as a stimulus which tends to evoke a response adapted to that end, while the term will is employed to denote the stimulative aspect of these cognitive processes. The doctrine of freedom merely asserts that purposes and intentions do influence conduct, that mind is an effective factor in shaping the course of human events, and in this sense of the term the popular belief in volitional freedom is certainly justified.

No one maintains that the will is wholly free in the sense that we can do whatever we desire. Every individual is obviously limited by his social and physical environment. We can not stop the tides, nor move mountains, nor be in two places at once no matter how much we may desire to do so. In fact this world would be a topsy-turvy land if we all were endowed with the Aladdin-like power of gratifying our every wish and whim.

Neither is the will free in the sense that we can attain our ends by the mere expression of our desires for them. The term does not imply any immunity from work and effort. Man attains freedom through knowledge, — by learning how to circumvent and transform nature to suit his own purposes, and much time and effort is requisite for the development of such knowledge. Man has gradually freed himself from his environmental handicaps by spanning the rivers with bridges, building boats, tunnelling the mountains, irrigating the deserts, tilling the soil, and harnessing the various forces of nature to do his bidding. Neither has man attained his full measure of freedom in-

asmuch as he has not as yet realized all his possibilities for intelligent development. Freedom comes through knowledge and knowledge must be sought, and we may well close this chapter by citing the old injunction that you shall seek the truth and the truth shall make you free.

EXERCISES

1. State the respects in which a voluntary act conforms to our definition of a mental act. See Chapter I.

2. What percentage of your daily activities are volitional?

3. Is will synonomous with choice? Does will presuppose a conflict and a resolution of that conflict? Can a conflict be resolved without will? Did you ever make a decision by flipping a coin? Was this a voluntary decision? Under what conditions is this method justifiable?

4. What information could you give an individual that would help him in breaking a bad habit?

5. What directions would you give an individual for improving his ability to keep his mind upon what he is doing?

6. What are some of the means you would employ in developing will power in a child? Should parents ever attempt to break a child's will? Should they ever attempt to curb it? Should they always let the child have its own way?

7. If an individual's development is wholly determined by congenital and environmental influences, should he be held responsible for his wrong acts and be punished for them? Do some people uphold this doctrine? If an individual should never be punished, should he ever be censured or reprimanded? Should he ever be praised or rewarded for his good acts? Are the acts of an individual influenced by their social consequences? Does this argument presuppose free will on the part of society?

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CHAPTER XV

THE SELF

The behavior of any organism, the character of its environmental contacts, and hence the nature of its experiences are determined by two sets of conditions, — the nature of the organism and the character of the environmental situation with which it is confronted. The importance of the organic conditions was specifically stated in Chapter IV, and their functional influences have been depicted from time to time throughout the remainder of the text. These organic conditions may be either innate or acquired. Native or innate conditions are those which are present at birth or those, like sex, which normally appear during the course of organic growth, while the acquired conditions are a product of the organism's reactions to its environmental contacts.

Native Conditions. — Native conditions endow an organism with a restricted range of *capacity*, — certain possibilities and limitations of action. The nature of an organism's sensory equipment determines its capacity for environmental contacts, while its motor equipment conditions its possibilities of responding to these contacts. Organisms differ very materially in their discriminative capacity as well as in their motor ability (Chap. III). Some animals can fly, others can walk and run, while others perforce must creep and crawl. Furthermore, the capacity for highly variable and coördinated action in response to

each object of sense is also dependent upon the degree of neural development (Chap. II), while any limitations of locomotor and manipulative ability will naturally operate to restrict the range of potential environmental contacts.

Native conditions also endow an organism with *preferences* and *propensities*, — a disposition to realize certain possibilities rather than others. These conditions are various. Peculiarities of sensory equipment account for the fact that we are more sensitive to certain objects than to others. For example, the retina is much more sensitive to foveal than to peripheral stimulations, while the peripheral portions are more sensitive to moving than to stationary objects. Likewise any motor apparatus is so constituted that it is prone to react in certain ways rather than by other types of response of which it is capable. Each human voice has a given range of pitch capacity, but the emission of the high and low tones lying near the limits of its capacity is attended with considerable difficulty, while the middle tones can be produced with a greater ease and readiness. Thus it is proper to say that each human voice has its natural pitch proclivities, and what is true of pitch also obtains for the other aspects of voice such as intensity, rhythm, and timbre quality.

There are also certain preferred pathways of neural discharge. The existence of the various reflexes is an indubitable proof of this fact, and these neural conditions account in part for the facts that we are prone to react to certain objects rather than to others, and that a given object is more likely to elicit one type of response than another. As stated in Chapter XIII, native conditions undoubtedly account for the affective tone of some objects and for certain of our likes and aversions for things, and one theory conceives of these conditions in terms of the native adaptive

tendencies of the organism which obviously presuppose the existence of certain preferred pathways of neural discharge. The intelligent and vital activities of an organism are mutually related in an intimate fashion (Chap. XII), and this fact accounts in part for many of the native volitional and emotional traits that characterize the actions of different species of animals, such as their sluggishness, their restlessness and aggressiveness, and their timidity and pugnacity.

All of the fundamental motivations of life constitute a part of our organic inheritance, and necessarily these motivating conditions exert a directive influence upon our reactions in virtue of the fact that only certain types of response and environmental contacts are capable of satisfying them. Organisms differ very considerably in their natural endowments in this respect. For example, some animals are herbivorous and others are carnivorous by nature. The influence of all these native conditions is readily apparent when we contrast the environmental preferences and mode of life of widely separated species of organisms. Some animals are so constituted that they can live only in the water, some only on the land, while others are equally at home in either environment. Again, some animals can live and thrive only in the tropics, some in arctic regions, while others are capable of adapting to a wide variety of climatic conditions. Such examples emphasize not only the importance but the great variety of these native conditions. Practically every feature of an organism's structure exerts some degree of influence in determining the nature of its environmental contacts or its mode of responding to them.

Organisms also possess a certain amount of native retentive capacity, — the capacity for altering their reactive

disposition by means of their own responses. This capacity undoubtedly varies with the species, and it is entirely possible that it may vary to some extent from individual to individual within a given species. Retentive capacity thus endows an organism with the ability to learn, — the ability to keep continually acquiring new modes of response in virtue of its previous reactions.

Acquired Conditions. — In our previous descriptions of the process of utilizing the accumulated experiences of the past in adjusting to new situations, we have employed the phraseology of popular speech which erroneously implies that experiential activities are enduring entities whose preservation and reinstatement are essential to their subsequent use. It is obvious on a moment's reflection that mental phenomena such as perception, ideas, emotions, reasoning, and volitional decisions are not *things* but mere *events* which have no more enduring existence than the swaying of a tree in the wind. Strictly speaking, it is not the experiences or activities per se but their *organic effects* which are retained and which are effective in determining the character of the subsequent responses of the organism. Each distinctive experience leaves certain organic effects, and each of these endows the organism with a propensity for a certain type of subsequent response. It is thus evident that these *acquired* conditions which are the product of the organism's own reactions must be conceived in a fashion similar to those innate conditions which endow an organism with its native propensities for action.

These persistent effects of our reactions are various. First, we may note the direct effect of the act upon the sensory, neural, and motor structures involved. It is usually assumed that only the neural structures are modified, and these modifications are generally conceived in terms of an

alteration of synaptic resistances, — the formation of new pathways of nervous discharge. Undoubtedly these neural modifications are the most important, but there is no good reason for assuming that the preferential sensitivity of the receptive structures remains unaltered, while it is a well known fact that any extensive exercise of a motor apparatus is conducive to its energy of response. The functional relations of mental acts to the vital processes are altered, and these modifications account in part for many of our acquired emotional and volitional traits, such as timidity, diffidence, recklessness, assertiveness, and self-confidence. Acts also exert certain *indirect* effects upon the reactive disposition of the organism. The retention of any act is influenced by the character of its consequences, by its success or failure in satisfying the conditions which motivated it (p. 92). Acts which attain a desired result will naturally exert a different effect upon the reactive disposition of the organism from that brought about by acts with undesirable consequences. Finally, all activities which indirectly affect the vital processes and promote or disturb the permanent well-being of the organism will naturally influence its subsequent manner of response. Various traits and reactive attitudes such as peevishness, irritability, moodiness, geniality, cheerfulness, optimism, and perserverance may be profoundly modified in this manner.

The attainments, or present acquisitions, of an individual necessarily influence the character of his subsequent development, for what a person can or can not learn to do is to a large extent a function of his previous experiences. For example, the acquisition of the ability to walk or talk enables a person to acquire many other types of experience which would otherwise be impossible, while the mastery of

the principles of geometry is a necessary prerequisite for the acquisition of other types of mathematical knowledge. As has been emphasized throughout the text, every organism invariably solves each new situation with which it is confronted in terms of its previous experiences, and obviously what any organism can learn to do is thus dependent to some extent upon the character of its previous acquisitions. Our past experiences also exert an inhibitory effect upon the acquisition of other types of response and thus restrict our possibilities of development along certain lines. No one can realize all of the potentialities of his nature. Development in one direction necessarily precludes the possibility of developing along other lines. No one can be both vulgar and refined, candid and deceitful, or a vagabond and a respected member of society. Beliefs, traits of character, and modes of reaction that are useful in one occupation are sometimes detrimental to success in some other line of activity. The proverbial Jack-of-all-trades is usually a failure. Some degree of specialization is essential to success, and specialization in one line of activity naturally limits to some extent a person's ability for any radically different type of occupation. A person's attainments thus condition his possibilities and limitations for further development.

The Concepts of Self and Human Nature. — These native and acquired conditions thus account for the reactive possibilities of any individual, — his capacities, his attainments, and his possibilities and limitations for further development. The term 'self' will be employed to refer to any human individual regarded from the standpoint of his reactive possibilities. Obviously, what any individual can and can not do, his characteristic ways of doing things, his abilities and attainments, and his possibilities for further

development constitute the very essence of his being or self. This usage of the term is quite obvious when we refer to 'ourself' as an object of thought. Although individuals differ to some extent in their reactive possibilities, yet they have much that is common in the way of both capacity and attainment, and the term 'human nature' is used to denote all those reactive capacities and characteristics that are common to all people. A knowledge of human nature will thus enable one to predict what any individual may reasonably be expected to do in any given situation.

The Growth of the Self. — The self undergoes a process of growth and development. The fact of growth means not only that the self changes during life, but that the nature of these changes and accretions is dependent in part upon previous conditions. The nature of any mature self is to some extent a product or an outgrowth of its childhood characteristics, or, in other words, the various bents and inclinations of a person's early life necessarily color all of his subsequent development. This fact is well exemplified by the old adage that the tree grows as the twig is bent.

The fact of growth, so far as our acquisitions and attainments are concerned, is obvious from the preceding discussion. The way we react to any new situation is conditioned by our previous modes of reaction to similar situations. What we can or can not learn to do at any given period of our development is conditioned by the nature of our previous acquisitions. The nature of every new experience is in part a function of our previous experiences, and it in turn exerts some effect upon the character of our subsequent reactions. All acts are thus expressions of a self and contribute to the further development of that self, and hence all of the acquired characteristics of our mature self must be regarded as an outgrowth of our previous stages of de-

velopment. The self thus grows in exactly the same sense as does a tree or any living organism.

The growth of the self is also due in part to the maturation of the organism. Not all of our native capacity is present at birth. While present knowledge will not permit of any very confident statements, yet it is highly probable that the full attainment of our sensory, neural, and retentive capacity must await a certain amount of development on the part of the structures involved. For example, while all of the neurones are present at birth, yet it is a well known fact that they undergo a considerable amount of development in respect to size, medullation, and degree of arborization, and it is hardly conceivable that such structural changes will involve no alteration in the functional capacity of the nervous system. Our motor capacity undoubtedly increases with bodily growth. The rapid development of motor ability during youth can not be wholly accounted for in terms of practice and training. Such factors as strength and endurance at least are dependent upon the growth of the organism. No matter what a person's training might be, he would never develop a normal amount of locomotor and manipulative ability, if he were to retain throughout life the puny limbs and body of an infant. Lack of growth would seriously interfere with our normal development by restricting the range of our environmental contacts and limiting our ability to deal with the world in an effective fashion. Imagine the effects which a lack of motor development would exert upon the present industrial organization of society! Obviously the capacity to do a man's work in the world presupposes a considerable amount of muscular development.

The growth and maturation of the organism likewise accounts for certain changes in what we have termed

our preferences and propensities. Several examples may be cited in the way of illustration. Our preferences for food are radically altered as a consequence of physical development. Witness the change from a liquid to a solid diet, and the change in our attitudes toward sweets and fats during the course of life. Physical maturation also accounts for the emergence of the sex motive which, as is well known, exerts a very considerable influence over the course of our subsequent development (p. 265).

Outside of a few obvious cases like sex and motor capacity, our present knowledge will permit of no confident statement concerning the details of the relation between organic growth and mental development. We lack sufficient knowledge about many factors of growth and their significance for mental development, nor are we able to specify all those features of our developmental history which are either directly or indirectly conditioned upon the maturation of the organism. To a large extent the details of this relation must remain for the present a matter of opinion and speculation.

The Formative Influence of Early Impressions. — All other conditions being similar, the earlier an impression, the greater will be its formative influence upon the development of the self. Youth is rightly regarded as the plastic and impressionable period of life. Not only will impressions received at this time exert a more pronounced and characteristic effect upon the subsequent reactions of the individual, but also this influence will obviously be operative over a considerably longer period of time. Plasticity is frequently regarded as a *native* characteristic of an immature organism. Nervous tissue is conceived as soft and pliant in youth, but as hardening with age. This doctrine may contain an element of truth, but the plasticity

and impressionability of youth are mainly due to the absence of any extensive system of thoroughly established modes of reacting toward the world, while on the other hand the inflexibility of the adult must be regarded as a product of the rigid system of habits, beliefs, and mental attitudes which he has developed during the course of life. The effect exerted by any impression depends upon the nature of the individual's response with reference to it, and obviously the character of an adult's response will be a function of his established system of habits. An example of honest conduct will naturally exert but little additional effect upon the beliefs or actions of a thoroughly honest man, and examples of duplicity will merely serve to arouse some expression of his condemnation or disapproval. A given trait may be readily developed by a child in the absence of any definite propensities to the contrary. A few distinctive experiences are often sufficient to initiate some characteristic mode of reaction which, under favorable circumstances, may soon develop such a strength as to be resistant to all sporadic attempts at social control.

We must not naïvely assume that a child learns only when it is *taught*. The infant learns in virtue of its own adjustive efforts, and the parents necessarily determine the character of its development in so far as they either directly or indirectly influence its reactions. It is now generally recognized that mental development begins in early infancy. It is not only possible to trace the roots of many of our most important adult traits back to the period of infancy, but it also must be noted that some of these traits often become so firmly established at the age of four or five years that they may persist practically unmodified throughout the remainder of our lives. As examples we may cite such traits and characteristics as temper, stubborn-

ness, diffidence, grit, self-reliance, initiative, perseverance, candor, honesty, and deceit. While it is entirely possible that certain of these childhood traits may find their origin in some native propensity for action, yet we must recognize the fact that any trait as exhibited by a four year old child has undergone a considerable amount of development, and we must also avoid the quite common error of regarding the strength and early appearance of a trait as a sufficient proof of its native character.

Acts as Expressions of the Self. — The ability to perform any act is a product of previous experiences, but we are prone to assume that the performance of that act is conditioned merely by those few experiences which were involved in its acquisition, — that the ability to repeat a poem is dependent upon only those experiences involved in the few repetitions required to memorize it, or that the ability to thread a maze is conditioned only by the few trials which were required to master it. On the contrary, we maintain that the ability to perform any act is conditioned upon the retention and functional efficiency of a great variety of experiences dating as far back as the period of infancy, and that it would be more nearly true to say that practically the whole self is expressed in every act.

As we have emphasized throughout the text, each new problematical situation is solved in terms of our previously acquired modes of reacting to similar situations. But those modes of reaction were also acquired in terms of previous acquisitions, and these in turn were also the products of former experiences. Obviously every act which we perform has thus a long and complicated genetic history.

The truth of the above proposition may be exemplified by the analysis of some particular bit of behavior. Let us

consider the performance of a student of geometry in demonstrating his solution of some assigned problem. First, this act is conditioned upon the efforts involved in discovering and memorizing the solution of the problem on the preceding day. This solution, however, involved the application of the student's knowledge concerning several propositions previously mastered, and these propositions in turn were solved on the basis of his knowledge of other propositions, and these again were comprehended only in virtue of his knowledge derived from the study of some preceding principles, so that we may legitimately assert that practically the whole of his geometrical knowledge was involved in the solution of this particular problem. The acquisition of this geometrical knowledge also involves a considerable amount of previous training and experience. It at least presupposes the ability to read and talk. A certain amount of algebraical and arithmetical knowledge is also a prerequisite, while the comprehension of the various axioms and such geometrical concepts as equality, angle, circle, cube, and sphere is conditioned upon a rather extensive experience in dealing with a world of spatial objects. This act of demonstrating the solution of the problem also involves the ability to walk, stand erect, and write and draw, and some practice was essential to the development of these bodily coördinations. Our possibilities of analysis are not yet exhausted. The solution of this problem was perhaps dependent upon the prior development of some more general habits and characteristics of mind such as industry, ambition, perseverance, and mental ingenuity. We may also consider some of the special characteristics of the student's performance such as his grace or awkwardness of movement, his readiness of speech and nicety of diction, the logical clarity of his presentation,

his modesty of demeanor and courtesy of manner, and finally his confidence and self-assurance.

Besides its own genetic history, every act thus exhibits certain special features which reflect some of the more general characteristics of the self. Practically every experience of our lifetime has contributed its mite of influence in determining the exact degree of our self-confidence and assertiveness. Among these general characteristics whose genetic roots permeate so widely throughout every aspect of our selves, we may mention as examples such traits as cordiality, reserve, courtesy, candor, pride, taciturnity, caution, conceit, blatancy, punctuality, adaptability, honesty, deceitfulness, ambition, faithfulness, perseverance, thrift, loyalty, optimism, and self-reliance.

This genetic conception explains the strength and inflexibility of many of our characteristic traits, beliefs and attitudes toward the world. Parents and educators are often surprised and somewhat mystified at their inability to cope with some apparently simple undesirable characteristic because they fail to appreciate the extent of its genetic ramifications. For example, lack of interest or a slight aversion to academic success on the part of an intelligent boy may be the cumulative product of a great variety of contributing factors, some of which may date far back to early childhood. The disruption of any deep seated tendency will obviously involve a somewhat extensive reorganization of the self, while the inculcation of an inhibitory antagonistic attitude will necessarily require the expenditure of a considerable amount of time and energy for its development. The character of the self can not be materially modified in a day.

A habit may also undergo some degree of development prior to its first overt expression. Let us take as an ex-

ample the case of a boy who smokes his first cigarette at the age of sixteen, and whose mother decides to take the matter in hand at once in order to disrupt the practice before the habit has time to develop. To their surprise the parents may find themselves unable to cope with the situation, owing to the fact that the desire to smoke had been implanted in early life and had been gradually fostered by many fortuitous circumstances until it gathered sufficient strength to defy the inhibitions of parental disapproval.

The Unity of the Self. — The self is a product of our lifetime of experience. The self, however, does not consist of an accumulated mass of unorganized and unrelated items of experience. All new experiences are reflections of the self and in turn become incorporated as a part of that self. In the very process of acquisition, every experience of an individual necessarily becomes either directly or indirectly related to all of his previous experiences, and the self is a product of this unitary organization of the totality of our life's experiences.

The principles of organization are the two laws of association, — contiguity and assimilation, and the extent to which our experiences become associated with each other was suggested in the previous discussion of perception (p. 117).

All our various sensory experiences of a given object become organized into a perceptual system, and each object gets associated with all other members of its class. Each object is necessarily perceived in a somewhat variable spatial and temporal setting, and thus acquires a direct associative connection with a great variety of other objects. With the development of thought, the possibilities of association are greatly enhanced, for by the use of ideas the establishment of a contiguous association between ob-

jects is no longer subject to the limitations of time and space. In the course of time, every object thus acquires a direct associative connection with a great variety of other objects, and each of these has its direct associations with other objects, and these in turn are directly related to another series of objects. It is thus obvious that each object in virtue of its direct associations necessarily becomes indirectly connected with a great variety of other items of experience.

Objects also become indirectly connected in virtue of their direct association with some aspect of the percipient subject. Objects become associated with our feelings, emotions, and adjustive responses with their attendant satisfactions and dissatisfactions. For example, snakes are loathsome animals, and foods are objects that *satisfy hunger*. In perception, objects become directly associated with our own *body*. We not only perceive a tree on the bank of a lake, but we perceive it in the distance or as located directly in front of us. We perceive a pencil as held in the hand, a dog as sniffing at our legs, a chair as something in which we are sitting, an automobile as a rapidly approaching object, etc. It is readily apparent that in the course of perceptual experience we are just as likely to establish an effective association between a perceptual object and our own body as between any two perceptible objects. Writers often fail to note either the fact or importance of this type of personal relationship; it accounts in large part for the associative unity of mental life as well as for the 'personal reference' aspect of memory (p. 165).

The associative unity of our experiences is implied in the fact discussed in the preceding topic that practically every experience of our lifetime will find its reflection in some aspect of every complicated mental act, for our past

experiences can be involved in our reaction to any situation only in so far as they have some associative connection with it. This associative unity also accounts for our possibilities of ideational recall, for the attempt to trace out in a systematic and exhaustive manner all of the associative ramifications of any perceptual object will usually involve a reinstatement of the major portion of our knowledge of the world.

The Rational Organization of Experience. — Some sort of organization of our experiences is essential to their subsequent use, for any set of experiences can be utilized in reacting to a given situation only in so far as they have some associative connection with it. Moreover, the way we react to any situation will depend upon the nature of those experiences with which it is associated. A successful adjustment to any problem naturally presupposes the ability to utilize all those experiences which are *relevant* to its solution (p. 89). It is theoretically possible for the experiences of an individual to become so organized that he will react in a non-intelligent and irrational manner. For example, a person who is so organized that he can recall only his knowledge of history when confronted with a problem of mathematics, or vice versa, will not be regarded as a very intelligent individual. Neither will the action of an individual who flies into a fit of rage in response to a friendly greeting be considered as a rational type of behavior. It is thus obvious that the ability to react to the world in an effective, intelligent, and rational fashion depends upon the prior establishment of an *appropriate* system of associations.

As a matter of fact we do get our experiences organized for the most part in a serviceable fashion, and since this organization is based upon the principles of contiguity and

assimilation, it is evident that these modes of association are naturally conducive to an intelligent type of behavior. As an illustration of this pertinent fact, we may first cite the case of our topographical system of associations. Every object is perceived in a given spatial environment, and hence all of the permanent features of any perceptual situation will necessarily become effectively associated with each other in virtue of the fact that they are invariably perceived together (law of contiguity). In this way primitive man *naturally* develops a working knowledge of the topography of his surroundings, and, in the further attempt to systematize and expand this knowledge in the interest of a wider orientation to the world, we have the crude beginnings of a geographical science. The value of a topographical knowledge of the world is attested by the fact that it is taught in every school. It is an obvious prerequisite to the development of commerce and navigation. In fact any ready orientation to the complexities of a large city is dependent upon the adoption of some simple system of naming its streets. Without any topographical knowledge whatsoever, man would become a homeless wanderer on the face of the earth.

In the same way a person will establish an effective association between any two events that constantly recur together or in immediate succession (contiguity). An infant soon learns to anticipate the crash of thunder that follows a vivid flash of lightning, the painful consequences of grasping a hot object, and the parental disapproval that is evoked by certain of its acts. A person thus acquires in the course of time a working knowledge of all the obvious sequences of events, and utilizes this knowledge in guiding and controlling his conduct. Such knowledge enables a person to alter or control the natural sequence of events to

suit his own purposes, or to devise some satisfactory way of reacting to a situation before he encounters it. A knowledge of the consequences of acts is an essential condition for any rational or voluntary control of conduct (Chaps. IX and XIV), and, in this connection, it is well to note that science is engaged in the task of developing this knowledge of causal relationships by attempting to discover all of the invariable sequences of events that ordinarily escape our notice.

All successful responses which are discovered in the process of solving a problem necessarily become associated with that problem (contiguity), and may be utilized thereafter in reacting to it. We are also so constituted that these responses will be evoked by, and be utilized in reacting to, any similar situation which may be subsequently encountered (Assimilation). This automatic application of the fruits of past experience to new situations that arise is conducive for the most part to a successful type of response, and any occasional misapplications are quickly corrected in the give and take of experience. In later development this process is carried on in a more reflective manner known as generalizing, the attempt to discover and formulate the range of prospective situations to which any solution is applicable, and any experimental and systematic search for the various conditions which are essential to a valid generalization constitutes one of the features of a scientific investigation. Such a type of organization thus endows an individual with the ability to utilize his past experiences in reacting to novel situations in a very economical and effective fashion.

As intimated, a person may acquire certain detrimental and irrational associations. Having developed a rather pronounced emotional antagonism to a certain individual, I

find that I have automatically transferred this attitude to a new acquaintance because of some similarity of name, appearance, or manner, and that this fact has seriously interfered with the establishment of a cordial and friendly relationship. Many of our unreasonable dislikes and prejudices can be accounted for in a similar manner. Let us suppose that a young woman happens to hear the tolling of church bells while in a state of extreme nervous exhaustion and emotional despondency as a consequence of the sickness and death of her mother. This single experience may make such a profound impression that thereafter the sound of a church bell will be a sufficient stimulus to provoke a severe attack of emotional depression which may seriously interfere with her normal religious reactions. If the sound of the bell does not reinstate any of the circumstances under which the association was established, her behavior will naturally be regarded by both herself and her friends as an unreasonable and irrational type of response, — a condition which is likely to exert a very detrimental effect upon her subsequent mental development.

The Complexity of the Self. — The self, though a unit, is quite complex, exhibiting many diverse and often contradictory aspects which are known as partial selves. We are accustomed to speak of such aspects as our character or moral self, our ideal self, our mind or mental self, our bodily self, our subconscious self, our business or professional self, our political self, our religious self, our home or family self, our personality, our speculative or philosophical self, and our private or daydreaming self. With a few exceptions the meaning of these terms is obvious. Our personality comprises all those traits and characteristics that make or mar our efficiency in getting along and dealing with people, such as our courtesy, persuasiveness,

determination, adaptability, self-confidence, attractiveness, etc. The term mind is usually employed to refer to the more intellectual aspects of the self. The term bodily self is used to refer to all those aspects of the self which are obviously contributed by organic conditions, such as our bodily appetites of hunger and sex, the general background of intra-organic sensitivity, our superabundance of energy, etc. The subconscious self comprises all those acquisitions which have become submerged in the process of development (p. 249) and which manifest themselves only in some indirect fashion or under certain unusual circumstances.

As indicated, these partial selves frequently exhibit certain contradictory characteristics. A man may be honest in business and lack integrity in politics. He may be strong and vigorous of mind and weak in body, and vice versa. It is no uncommon occurrence for an individual to be kind-hearted, sympathetic, and benevolent in religious activities, and rather grasping and ruthless in his business dealings. A man may be gruff and inconsiderate at home, and quite courteous, agreeable, and charming in company. Our scientific and philosophical attitudes toward life do not always square with our religious and theological notions. Imagine the sudden transformation of character if all inhibitions were suddenly removed, and our daydreaming self should completely dominate our actions. One frank student remarked that in that event he would probably land in the penitentiary or the insane asylum within a week. The unity of the self does not imply consistency. A completely consistent self does not exist. Every one is a potential Dr. Jekyll and Mr. Hyde. The existence of these contradictions, however, does not necessarily convict one of insincerity and hypocrisy, for an individual may be inconsistent and be totally oblivious of the fact.

The concept of partial selves is not inconsistent with the doctrine that the entire self is usually active in every complex activity. The relative influence of any experience in determining our reactions varies with circumstances. Our response to one situation may be primarily determined by one group of experiences, and yet these same experiences may exert a minimum of influence in some other situation. It is thus possible for different types of situation to evoke different functional combinations of the totality of our experiences. The entire self may be active in every act and yet the way it functions will vary with circumstances. Entirely different aspects of the self will thus be revealed in different types of situation, and it is for this reason that any distinctively novel situation which a person encounters in the course of life is likely to reveal some hitherto unsuspected characteristics of his self. These partial selves must not be conceived in terms of certain limited systems of experience functioning in isolation. They represent, rather, different functional combinations of the totality of a person's experiences elicited by diverse situations. They represent merely different aspects of the same self characterized on the basis of the dominant type of activity involved in reacting to various sorts of situations. For example, when our responses to situations are primarily determined by intellectual considerations, those acts can be regarded as an expression of our mind or mental self. When moral considerations exert a decisive influence, the resultant act will be regarded as an expression of our moral self. Likewise all impulsions and desires for food due to ravenous hunger will be ascribed to the bodily self, while all unusual and unaccountable impulses and whims are usually ascribed to the activity of the subconscious self. Again it is my scientific or psychological self which I regard

as the active agent involved in the writing of this text. All our activities may thus be regarded as belonging to and as expressions of some one of these selves, and conversely each of these selves can be regarded as an active agency which exerts some appreciable influence upon the character of our reactions to the world.

Individual Differences. — Individuals differ very materially in their reactive characteristics. No two selves are ever exactly alike. In general individuals may vary in three respects. First, they may differ as to the character of the experiences that enter into their make-up. For example, one individual may be brought up from early life too exclusively in an environment of art and develop into an aesthete with no interest in the wider aspects of life. Another individual may early develop a taste for athletics and sports, and become a professional athlete, — having no knowledge of or interest in anything outside of the field of sports. Such people may be said to differ as to the *direction* of their development. Second, individuals may develop along similar lines, but differ primarily in the *degree* or amount of their development. Such differences are so obvious that illustrations are unnecessary. The most significant is the third type of variation. Two people with essentially the same background of experience both as to kind and amount may yet differ in the way in which these experiences have become organized in the process of self-development. Just as the so-called 'partial selves' represent different functional combinations of the same system of experiences, so may we assume that similar experiences, variously organized, can likewise account for a great variety of individual differences.

For example, two individuals may be reared in very similar environments, may receive the same educational

advantages, and enter the same profession. They have a similar background of experience, they have developed quite similar tastes and interests, and they may differ but little in respect to any one of an extensive series of traits such as honesty, loyalty, courtesy, cordiality, adaptability, conceit, self-confidence, willfulness, ambition, and aggressiveness. In spite of all these similarities, one individual may be highly successful in his chosen profession, while the other may exhibit a very mediocre type of ability for this work. Such differences of ability may be due primarily to what may be termed the 'general balance' of a number of traits. The one person may be successful because he has developed the proper degree of willfulness, aggression, and ambition tempered with the right amount of conceit, courtesy, and social adaptability, while the second individual has failed because too much modesty, tact, courtesy, and consideration of others have prevented the development of that amount of willful and domineering aggressiveness requisite for success in this particular job.

Very pronounced differences of individual ability may thus be due to very slight diversities of organization. One must not assume, as is so frequently done, that individual differences in ability are necessarily due to correspondingly large differences in congenital or environmental conditions. In accounting for the diversities of individual development, we must recognize the possibility that a very slight difference in congenital equipment or some very inconspicuous dissimilarity of environmental conditions during early life may be responsible for certain significant differences in the relative strength of a number of traits possessed by two individuals, without affecting to any appreciable extent either the degree or the general direction of their development. For example, the dissimilarity in the relative

strength of the series of traits cited above might well have been due to some difference of constitutional vigor, or to diverse methods of parental discipline employed during early youth.

Consciousness of the Self. — The extent to which our experiences involve a consciousness of the self is one of the controversial problems of psychology. This question, like many others, can not be answered without further analysis and amplification.

1. Are we conscious of the self at every moment of experience, or at some time during the course of every complete act of adjustment, or does the consciousness of the self emerge only during our reaction to certain types of situation?

2. Do we apprehend the self as a passive object upon which either our own activities or other objects exert some effect, or do we apprehend the self as the active agent which is reflected in our acts, — the self which perceives and thinks and acts on the basis of this knowledge?

3. There are four posible ways in which we may be conscious of the self. The self may be sensed, perceived, thought of, or inferentially apprehended in connection with the perception or thought of some other object. The term perception has been defined so as to include what is ordinarily meant by introspective observation (p. 111). The meaning of inferential apprehension may be illustrated by a few examples. I may perceive or think of a friend as the owner of an automobile. In this case the automobile is neither perceived nor thought of; it is inferentially apprehended. It is my friend that I am regarding as a potential object toward which to react, and I am apprehending him in terms of that attribute or characteristic which he acquired when he purchased a car. Again I may direct my thoughts to-

ward the automobile, and think of it as one which belongs to my friend. In this case it is my friend that is inferentially apprehended, for I am reacting toward the car on the basis of my knowledge of its ownership. From the preceding account of the nature of the self, it is obvious that only the bodily aspects of the self can be perceived or sensed. For the most part the self is a conceptual object which must be either thought of or inferentially apprehended.

We shall first consider the extent to which the self is inferentially apprehended. It is no uncommon occurrence to apprehend objects in terms of their personal significance. We perceive a house or hat as one which does or does not belong to us. We may perceive an approaching automobile as a thing which is dangerous to our life and limb. We may interpret a remark or an attitude of a companion as one which was expressly designed to flatter, irritate, or insult us. This personal reference is necessarily involved in all acts of memory (p. 165). Objects may also be apprehended in relation to the active self, as when we perceive an object as something which we dislike or desire. We may also regard our own acts from the standpoint of their personal consequences, and guide our conduct in the light of this knowledge. We frequently regulate our conduct on the basis of such considerations as health, personal safety, social prestige, and professional advancement. We may likewise regard our reactions to the world as an expression of the self. We perceive an act as something which we are doing, or think of it as something which we have done or intend to do in the immediate future.

We are not always conscious of the self in this manner, however. Thought is selective, and what we think of and the way we apprehend it will vary with circumstances.

Objects and actions are often regarded in a wholly impersonal manner. I may perceive an object in terms of its chemical composition, or think of a lump of coal from the standpoint of its geological history. Likewise, our own reactions to the world are sometimes regarded solely in terms of their effect upon a certain object or upon some other individual. Neither does this reference to the self emerge in every act of adjustment, nor is it invariably present, as many writers maintain, in every volitional decision. Problems may be conceived and solved in abstract and impersonal terms. For example, I may become interested in discovering the best way of handling a given situation, and, after canvassing the various possibilities, I make a decision and then react to the situation in order to test the validity of my conclusion. My interest was scientific and the solution was couched in *general* terms, for I was interested in discovering the most appropriate method for *any one* to deal with such a situation.

The self can also be directly apprehended as an object. We may imagine ourself as delivering a great oration, admire our virtues and accomplishments, become disgusted with ourself for our failures, estimate our liabilities as related to a certain position, and compare our personal characteristics with those of our friends. Although these cognitive activities may at times be both satisfying and profitable, yet no one will seriously maintain that we are continually engaged in this sort of self contemplation.

It is obvious that the bodily aspect of the self is ' sensed ' at all times. This mass of intraorganic sensitivity is always present and it continuously exerts a certain amount of influence upon the character of our mental life. It is only in this very restricted meaning of the term that one can say that he is always conscious of himself.

It must be admitted that the existence of the self is *implied* in all our reactions to the world. The self is a necessary implication of all organized experience. This doctrine merely means that each experience is related to a self, but it by no means follows that we are always conscious of this fact of self relation and are continually guiding our conduct on the basis of this knowledge. Such knowledge will arise and be useful only in certain types of situation.

The Training of the Self. — Primitive societies exerted but little *purposive control* over the mental development of their youth. For the most part, children were permitted to develop in virtue of their own reactions to the social and physical environment. As a matter of fact, societies incidentally did influence this development just in so far as the behavior of the adult members exerted an effect upon the reactions of the young. The statement merely means that these societies made no systematic and purposive attempt to control and regulate the reactions of their youthful members with the view of eliciting and developing certain desirable traits of mind, character, and personality.

We do find a very considerable amount of purposive control of the development of the young in all modern civilized societies. First, we have our formal system of education as represented by various types of schools. Such public and private institutions and agencies as our churches, municipal play grounds, libraries, juvenile courts, social settlements, hygienic and medical centres also attempt to exert a formative influence upon our youth. Besides these coöperative efforts, we have the institution of the home. Parents attempt to guide the development of their children in many ways. They choose a suitable environment in

which to rear their children, supervise their literature, amusements, and companions, teach ideals and values by precept and example, reprove wayward actions, and attempt to elicit and inculcate desirable traits of conduct such as courtesy, candor, thrift, honesty, and industry.

Modern society, however, has not as yet achieved its full measure of control, and further progress in this direction must await the formulation and dissemination of a more adequate and complete knowledge of the various factors and conditions that influence development.

To this end we need to develop a more explicit recognition of the fact that the various traits of mind, character and personality that constitute the most important part of our self can not be inculcated in the way in which we impart a knowledge of history and geography. For example, such traits as thrift, industry, initiative, courtesy, geniality, self-reliance, ingenuity, and emotional stability represent certain general characteristics of our habitual modes of reacting to situations, and these habits can be developed only through practice in much the same manner as we learn to play tennis or acquire skill in typewriting. We can cultivate geniality only by being genial to people until this type of behavior becomes automatic. We can acquire self-reliance only through the practice of this virtue, and no one can become thrifty and industrious unless he is given some opportunity and incentive for developing these habits. In other words, the character and the personality of a child are developed through its reactions to its social environment both within and without the school, and we can control its development only in so far as we can control this environment and regulate the nature of the child's responses toward it. Our present educational procedure places entirely too much emphasis and reliance

upon the more formal means of instruction. Character is something which can never be taught in the same manner as chemistry and history.

We must likewise cultivate a much keener sense of parental responsibility for the development of our youth. We are all somewhat inclined to assume that a child learns only when it is taught; we are prone to place too much reliance and responsibility upon the church and school for the up-bringing of our children. We fail to appreciate in any vital manner that a child develops its fundamental traits of character and personality in the very process of reacting to its social environment both within and without the school. Many of the most important characteristics of a self become firmly implanted before a child ever enters school (p. 342). It would perhaps be well to regard our scholastic system as a mere but necessary supplement to the wider education of life. Parents are largely responsible for the character of their children's development, for, no matter whether they intend to do so or not, they necessarily influence this development from early infancy just in so far as their behavior either directly or indirectly affects their children's reactions to the world. Parents must be taught to appreciate the fundamental fact that their actions necessarily exert a profound and lasting influence, especially upon the character and personality of their children, and they must learn to regulate their conduct at all times with a view to developing those traits which they deem desirable.

We need to devise a better technique for the training of desirable traits of character and personality. As a matter of fact, we do possess some practical knowledge of the conditions and influences that are conducive to the development of certain of the more cardinal virtues such as

honesty, thrift, and truthfulness. Society is also beginning to appreciate the fact that discontent, petulance, irritability, and emotional instability are sometimes due to remediable organic conditions. We have still much to learn in these respects, however. There is no universal recognition of the extent to which a child's mental and moral development is dependent upon his health and hygienic habits of life. We have developed no generally accepted and standardized modes of procedure for the training of character. We know practically nothing of the procedures necessary to inculcate such desirable personality traits as leadership, personal magnetism, vivacity, sympathy, moral courage, and social adaptability. We also lack any well attested and systematized knowledge of the best means of preventing and curbing such undesirable traits as undue diffidence, taciturnity, wilfulness, recklessness, conceit, and boastfulness.

Personality traits are intricately interrelated in respect to their development. Experiences that influence one trait may also exert either a favorable or unfavorable effect upon a number of other traits. For example, the attempt to cultivate ambition in a boy may detrimentally affect the development of a number of other desirable traits such as truthfulness, honor, candor, sympathy, and consideration for others. Likewise, the cultivation of social adaptability may exert a detrimental effect upon initiative, aggressiveness, and independence of thought and action. A thorough knowledge of these interrelationships is thus a prerequisite for the training of character and personality.

The educational endeavors of society have been so concerned with the problem of devising more adequate and effective means for imparting knowledge and developing intellectual traits and abilities that but little thought or

effort has been devoted to the equally important task of devising standardized procedures for the training of character and personality. This task constitutes one of the important problems of the future.

EXERCISES

1. Is retention to be explained entirely in terms of the nervous system? Can all animals learn? Does learning involve retention? Do all animals have a nervous system? See Chapters II & V.

2. In investigations of animal learning, why is it necessary to adapt the nature of the problem to the structural capacity of the animal? See Chapter V.

3. In what other chapters did we enunciate the doctrine that the intelligent capacity of an organism is to some extent a function of its structural equipment?

4. Can you suggest any other definitions of mind, self, personality, and human nature than those given in the text?

5. Does the greater plasticity of youth mean that children can learn more readily than adults? Compare with Chapter X.

6. In a given family both parents and children have unusually cheerful and buoyant dispositions. Is it necessary to explain this fact in terms of biological heredity? Might it be due to such inheritance?

7. How would you organize your knowledge so that you could recall it easily in those situations in which it would be of service and not be bothered with it under other circumstances? See Chapters X & XI.

8. State how you would cure a child of undue conceit. How would you disrupt taciturnity? State how you would cultivate self-responsibility in a child. How would you go about it to develop the quality of leadership in yourself?

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CHAPTER XVI

THE CONGENITAL BASIS OF MENTAL DEVELOPMENT

From the preceding discussion it is evident that the development of the self is a product of two sets of conditions, — the environment and the native constitution of the organism. In both popular and scientific thought, such questions frequently arise as the relative influence or importance of these two factors in shaping man's development, the extent to which a person's characteristics and abilities are due to nature or nurture, and the extent to which man's acts are an expression of native or acquired conditions.

Some General Principles. — It is possible to make several general statements concerning the relative influence of these factors, although no complete answer can be given on the basis of our present knowledge.

1. Both environmental and native conditions are *essential* to development, and from this standpoint both factors must be regarded as *equally* important.

2. No act or trait or ability can be explained entirely in terms of native conditions, for all characteristics of a self undergo a certain amount of development with experience.

3. Neither can any of the characteristics of a self be explained wholly in terms of acquired conditions, for all of our reactions to the world are to some extent a function

of our native constitution. For example, every acquired mode of response must find its ultimate genetic roots in our native propensities for action, while the possibility of developing any particular characteristic is at least dependent upon the structural capacity of the organism.

4. It is only certain *particular facts* about an act that can be explained exclusively in terms of either native or acquired conditions. In studying my reactions of anger, I may become successively interested in such a series of factual questions as why I became angry at a particular person, why I became angry at him on a certain occasion and not others, why I expressed my anger toward him with a certain degree of dignity and verbal restraint, or I may become interested in the more general questions as to why I get angry at all, or why I am more susceptible to anger than are many of my associates. Likewise in studying such an act of skill as walking, I may inquire why children begin to walk at a certain stage of development, why this time varies with individuals, why the first attempts are uncoördinated, why the performance improves with development, why we walk forwards and not backwards, and why individuals differ characteristically in gait and manner of walking. It is evident that certain of these questions must be explained primarily in terms of native conditions, some in terms of previous experience, others in terms of environmental circumstances, while others can not be explained wholly in terms of any one set of conditions.

5. It must be recognized that our present knowledge will not permit of an enumeration of all those reactive characteristics which are due to the innate constitution of the organism. While such facts as the change of voice at puberty, our aversion to pain, and the time at which a

child begins to walk are undoubtedly due in large part to native conditions, yet any opinions which we may entertain as to the native basis of such characteristics as racial prejudices, religious interests, unusual mathematical ability, the fairy story stage of child development, the feminine desire to be in style, etc., have but little scientific value.

6. The difficulty of isolating the influence of the native factors is complicated by the fact that the development of the self is due in part to experience and in part to organic growth (p. 340). The problem would be exceedingly simplified if organisms were unable to learn, or if they were born physically mature and all development were due to experience.

Criteria of Native Characteristics. — Instead of attempting to list all the various native characteristics of human nature, we shall confine our discussion to a critical evaluation of the various methods and devices which have been proposed for detecting the influence of these conditioning factors.

First, we must regard as native any characteristic which is manifested under circumstances which preclude the possibility of its acquisition. For this reason, all reactive characteristics present at birth are necessarily due to native conditions. The organic readjustments involved in our emotional reactions must also be regarded as having a native origin for the very nature of these activities precludes the possibility of their being learned. The female of certain of the solitary wasps emerges from the grub full-grown, and in time digs a burrow in the ground for a nest, deposits her eggs, seeks and kills her prey which she drags to and deposits in her nest as food for the developing larvae. This cycle of activities must be regarded

as native for the reactions are common and peculiar to all members of the species, and all possibility of their acquisition and dissemination through social contact is excluded by the solitary mode of existence of these organisms. Social contact may be experimentally prevented in the case of other animals. Birds may be hatched and reared in isolation from their kind, and under these circumstances they exhibit many of the distinctive behavior characteristics of their species, such as voice, mode of life, mating, nest building, incubation, and care of the young.

In applying this principle, one must be certain that the possibility of learning has been thoroughly excluded. As noted in the previous chapter, parents frequently label many of the early appearing traits of their children as instinctive because they fail to understand how such fundamental traits of character can be acquired so early in life (p. 343). Likewise, people are prone to regard any trait as native just in so far as they are unable to explain it in genetic terms. The term instinct thus comes to mean in part that which is genetically unanalyzable and irreducible, and it is thus highly probable that in many cases the use of the term merely indicates our ignorance of genetic relations.

The influence of innate conditions in the development of social traits may be tested through an experimental control of the social environment. The method is particularly applicable to certain kinds of animals. The songs of birds have been generally regarded as an expression of their native constitution because they are so characteristic of the species. In several experiments, birds reared in isolation from their kind developed voice characteristics that only partly resembled those of their species. When other individuals were reared with adult birds of a different species,

they developed voice characteristics that resembled both those of their own species and those of the species with which they were reared. These two facts prove that the normal voice characteristics of this species of birds are due in part to native conditions and in part to their normal social contacts. For much the same reason, we know that the kind of language and the character of many of the social attitudes developed by children are a function of the social environment in which they are reared. Wild pigeons invariably mate with members of their own species, and for this reason it is frequently asserted that they are endowed with an instinctive mating preference. This doctrine has been experimentally disproved. It was found that these birds when hatched and reared by members of a different species usually preferred to mate with that species and could rarely be induced to pair with their own kind. Obviously the mating preference of these birds is largely determined by their normal social contacts.

Characteristics that appear at a *definite period* of development are usually regarded as native. Children go through certain successive stages of development in which they are interested in fairy stories, stories of adventure, playing with dolls, playing Indian, hunting, collecting stamps, etc., and it is assumed that this succession of interests is due to a corresponding series of organic changes involved in physical growth. This doctrine can not be accepted without qualification, for our *acquired* reactive characteristics may likewise exhibit a certain definite order of development. What we can learn at one stage of development depends upon the nature of our previous acquisitions. The ability to read is a prerequisite to many other forms of activity, and the development of geometrical concepts presupposes an extensive perceptual experience

with a spatial world. Educational customs may likewise determine to some extent the order of mental development. Since we are always confronted with the possibility that some of these growth characteristics represent necessary stages in the development of experience, it is well to regard as native only those characteristics that are obviously correlated with some structural change incident to the normal growth of the organism, such as the time a child begins to walk or talk, the change of voice at puberty, sexual interests, etc. In the absence of any known structural correlates, it is well to maintain a sceptical attitude toward the alleged instinctive character of the collecting and hunting activities of children.

It has been suggested that characteristics which appear suddenly in a fully developed form are necessarily native in origin, while all those that exhibit development and improvement are acquired. The principle is fallacious. As previously noted, acquired reactions may undergo a considerable amount of development prior to their first expression (p. 346). Furthermore, it is reasonable to assume that certain native characteristics may slowly ripen with the growth of the organism. For example, it is possible that the improvement of a child's ability to walk is as much due to the growth of the organism as to practice. The influence of the native factor in such a case can be isolated only by an experiment in which the possibility of learning is prevented. Obviously, this means of control can be utilized only with animals and with certain behavior characteristics. The method has been applied to the pecking response of chicks. In one group, the chicks were allowed to secure their food by pecking, and the improvement of the act in accuracy was measured from day to day. Practice in pecking in other groups was prevented by keeping

the chicks in the dark and feeding them by hand. After the period of no practice, the chicks were allowed to feed as usual and the increasing accuracy of the response was measured as before. It was found that the *initial* accuracy of the act was not significantly altered with the lack of practice; in other words, when practice was prevented the initial accuracy did not improve with age. While no improvement occurred without practice, yet it was found that the *rate* of improvement due to practice was much more rapid with the older chicks.

A *biological utility* is usually regarded as a characteristic of all native traits. As a means of differentiating between native and acquired traits the principle is practically worthless. Certain acquired ways of reacting are just as directly related to individual and racial survival as are any of the natively conditioned reactions such as fear and the avoidance of pain. Medical and hygienic knowledge and practices may be cited as examples. The assumption that all native characteristics are biologically useful is also unwarranted. According to the theory of natural selection, only those traits that are detrimental to survival are necessarily eliminated. The theory logically permits of the development and perpetuation of characters that possess no survival value. Furthermore, evolutionary traits need to be conducive to the preservation of life only at the time of their origin. Traits that developed and were serviceable under primitive conditions of life may be no longer useful under present social conditions. Fear of strange objects which is usually regarded as a native characteristic obviously contributes but little to the preservation of life in any civilized community.

This biological argument is sometimes employed by those who are desirous of justifying, exalting, or strengthening

their belief in the value and worth of desirable human traits. If native things are good, obviously our belief in the worth of a trait will be strengthened by a knowledge of its instinctive origin. This motive is partly responsible for the assumption of the existence of a religious instinct. Labor achieves an added dignity and respect if we can trace its origin to an instinct of workmanship. Such altruistic traits as sympathy, self-sacrifice, and loyalty take on an added worth if we ascribe to them a natural origin. Similarly some people tacitly assume that instincts are divinely implanted tendencies, and hence they are accustomed to endow such a trait as mother love with a certain halo of mystery and spirituality by labelling it an instinct. The validity of these arguments needs no comment.

Mental traits and abilities are necessarily native in so far as they are biologically *inherited*. Several attempts have been made to identify certain native characteristics by this means. It is known that idiocy, mental degeneracy, and some cases of mental deficiency are often correlated with certain physical stigmata which have obviously been transmitted from generation to generation. The native character of such traits as savageness has been established by crossing wild and tame rats and comparing the savageness of the offspring with that of the parent rats. In this test the possibility of social inheritance must be eliminated. This can be accomplished by mating a wild male with a tame female, and a wild female with a tame male, and removing the males from the cages before the litters are born. If the young of both litters now develop traits like those of the respective mothers, the fact must be explained in terms of social heredity. On the other hand, if the young develop traits intermediate between those of the parents,

it is evident that the two males must have exerted an influence upon the young and that this influence was transmitted by means of organic inheritance. It is exceedingly difficult to eliminate the influence of the social factor in the study of human traits. Most studies of the inheritance of musical ability are defective in this respect. It is known that many heritable structural characters such as color are distributed among the successive generations of progeny according to what is known as the Mendelian ratio. It is now assumed that any mental trait must be natively conditioned in so far as it is transmitted in accordance with Mendelian principles. The method has been extensively employed in the study of human traits and abilities. For example, a married couple is located, each of whom is known to possess a certain distinctive trait such as timidity and pugnacity respectively, and the distribution of these traits is then studied for several generations of their descendants. Given a Mendelian ratio, the traits in question are regarded as native in character. The method is apparently sound in principle, for this particular type of distribution could hardly be due to social inheritance except in rare instances. Serious difficulties are encountered in the application of the method. It is no easy matter to obtain reliable information concerning all members of each succeeding generation. It is often exceedingly difficult to make a reliable judgment as to the degree to which a trait is present in any given individual. In so far as any trait is *partly* determined by environmental circumstances, its distribution will naturally deviate from the Mendelian norm, and it is quite apparent, in the case of any pronounced deviations, that the distribution may be rightly regarded as due entirely to environmental influences. One can make a confident statement as to the native basis of a

trait only when its distribution very closely approximates the Mendelian norm.

A method recently employed for isolating native traits involves the comparison of the mental resemblances of twins, identical twins, and siblings. Identical twins are those that have developed from the same ovum, while the term siblings refers to two children born of the same parents at different times. The method assumes that identical twins are most alike and a pair of siblings the least alike from the standpoint of inheritance. The three pairs are now quantitatively compared as to their relative degree of resemblance in respect to a large number of mental traits and abilities. It is assumed that all those traits are hereditarily determined in respect to which the greatest and the least degree of resemblance is exhibited by the identical twins and the siblings respectively. Except for the serious difficulty involved in identifying identical twins, the method is reasonably valid in so far as twins and identical twins are concerned, provided the comparison is based upon a sufficiently large number of cases to eliminate the influence of chance factors.

The method is fallacious when siblings are employed, for their greater difference in mental characteristics may be due to developmental circumstances. Two children of different ages, although reared in the same home, will naturally differ as to the character of their social contacts. The reactions of the parents to the youngest child will be modified by their greater maturity and the experience gained in training the older children. The age factor will influence the character of the social interaction of the two children upon each other. There is also the possibility that the social and financial status of the family may be radically altered before the birth of the second child. Assuming

that the family continues to live in the same neighborhood, there is no guarantee that the two children will come into contact with a similar set of associates. The possibility of differences in social influence can never be eliminated in the case of siblings.

Habits are said to be plastic and modifiable, while innate traits are regarded as not *amenable to control.* As previously noted, parents are prone to ascribe a native or congenital origin to the intractable traits of their children (p. 368). As a means of differentiation, the principle is not valid. There is no good evidence that all native characteristics are necessarily intractable and unmodifiable, while it is well known that all thoroughly established habits of thought and action are extremely resistant to control.

The assumption has been made that native characteristics are *inevitable* in the sense that they naturally appear in the course of development or in spite of all attempts at prevention. Likewise, native traits are said to be *ineradicable* in the sense that they keep spontaneously reappearing in successive generations in spite of all attempts at suppression and elimination. This assumption is probably valid, but native and acquired traits can not be differentiated on such a basis, for these same attributes may also characterize certain acquired traits. For example, the self may go through certain necessary stages of development in the process of acquiring experience, and there are some things which every organism, both animal and human, must learn to do if it is to continue to live and exist in the environment in which it finds itself.

The method of *species comparisons* has been employed to identify native traits. Traits with a long phylogenetic history, *i.e.,* those that are widely distributed throughout

the animal world, are usually regarded as native. Fear, anger, curiosity, and parental care are usually cited as examples. The doctrine assumes that traits that are common to a large number of species living under widely different conditions can not be due to those conditions. The principle must be applied with a considerable degree of caution, however. First, there are certain respects in which all environmental situations are similar. For example, most organisms are accustomed to avoid running into solid objects which they meet, and yet no one would seriously maintain that the wide distribution of this reaction is a proof of its instinctive character. Furthermore, it is well to view with suspicion the prevalent assumption that traits like parental care that are known to be native to several species of animals are necessarily native in man. Undoubtedly all specific differences of behavior that are obviously *correlated* with differences of structure must be regarded as native. Such differences of locomotor activity as swimming, crawling, walking, and flying can be cited as examples. Specific differences of reaction to the same aspect of the environment are also natively conditioned. For example, certain species react toward and others away from the source of a light of a given intensity, and this difference of behavior must be explained at least in part in terms of native conditions.

Universal or *specific* traits, *i.e.*, those common to all members of the species, are usually regarded as native. As previously noted, specific traits in social animals may be in part a function of the social environment (p. 368). Specific traits in animals are necessarily native only when the possible influence of the environmental factor has been eliminated, as in the case of the solitary species or the geographical separation of several groups belonging to the

same species. The difficulty of excluding the influence of the social factor is obvious in the case of man, and furthermore human development may exhibit certain uniformities due to the fact that we are all forced to adjust to the same sort of a physical world. The notion of a deity was once regarded as an innate possession of the mind because of its universal distribution. The same argument has been advanced in support of the existence of a religious instinct. Because of its universality, one popular writer has asserted that the dream of falling is an experience which has been inherited from our primitive ancestry (p. 168). A belief in the native character of the so-called necessary truths such as geometrical axioms has been supported by the same argument. So far as its application to man is concerned, the principle is practically worthless. In fact, as noted in the previous paragraph, the distribution of a mode of behavior throughout a *large number of species* does not constitute a sufficient proof of its instinctive character.

Some writers assert that *individual differences* are mainly due to native conditions. Several arguments are advanced in support of this proposition. First, there is the obvious fact that deficient and abnormal development is usually correlated with physical stigmata as in the case of idiocy. This fact, however, does not justify the conclusion that the degree of normal development is likewise limited by native conditions. Again, individuals differ considerably when they are reared in the same community and are given approximately similar educational advantages. This argument ignores the fact that a person's development depends, not upon the environment in which he is reared, but upon the character of his environmental contacts. No two individuals, even of the same family, are ever subject

to exactly the same set of environmental influences. Furthermore, it must be recognized that slight environmental differences in early youth may produce quite diverse effects upon later development. The influence of native conditions is also inferred from the fact that superior and gifted minds often develop amidst unfavorable surroundings. The career of Lincoln may be cited as an example. This type of argument must be viewed with suspicion, for it may be questioned whether even a Lincoln would have manifested any unusual attainments if he had been reared in an atmosphere of culture and had lived at a different period of history.

Not only do we encounter the insuperable difficulty of evaluating the relative influence of the two factors in many cases, but it is entirely probable that their relative influence varies to a considerable extent with the particular trait and pair of individuals under consideration. For example, individual differences in courtesy, thrift, honesty, punctuality, and self-reliance are mainly due to diversities of training, while differences in muscular strength, sensory discrimination, speed of reaction, and pitch and timbre characteristics of the voice are primarily due to structural differences in the majority of cases. Two individuals may differ in respect to their musical, golfing, or swimming ability because of differences in training, while two other individuals may differ in these respects because of differences of constitutional capacity. Because idiocy is due to a constitutional defect, we must not conclude that native conditions are responsible for the difference in intelligence of two normal children. Thus no one is justified in making any *general* statement as to the relative importance of these two factors in individual development.

The various criteria of native characteristics which we have enumerated can, in so far as they are valid, be conveniently subsumed under three general principles.

1. Any trait may be regarded as native when the possibility of learning and environmental influences are in the nature of the case precluded, or when these factors have been excluded or controlled by experimental means. The validity of this method depends upon the certainty with which these factors have been eliminated.

2. A mental trait or ability can be regarded as native in so far as it can indubitably be correlated with some structural characteristic of the organism. This method generally yields the most decisive and unambiguous results.

3. All mental traits and abilities are native in so far as it can be demonstrated that they are biologically transmitted from generation to generation. This method is like the first in so far as it involves the exclusion of all possible means of social inheritance.

The fact must be recognized that the isolation and identification of native traits is a much more difficult problem in the case of man than it is with animals. The problem is complicated by the fact that human development is much more subject to the influence of the social factor. Likewise, man has a long period of youth in which his development is due in part to organic growth and in part to the acquisition of experience. Finally, certain of these methods can not be employed in the identification of human traits. For example, any experimental attempt to prevent learning, to regulate inheritance, or to eliminate and control the influence of the social factor is hardly feasible with human subjects. The two factors are so inextricably woven together in human development and the difficulties of separating them are so great, that it is well to refrain from

making any positive assertions as to the native character of a mental trait except in those cases where the evidence is wholly unambiguous.

Concept of Instinct. — Authors are accustomed to discuss these innate and congenital aspects of human development under the more restricted topic of instinct. Lists of human instincts may be found in many texts, but a comparison of these lists soon reveals a considerable amount of disagreement as to the instinctive character of many traits. For example, from an examination of seven standard textbooks, it was found that acquisitiveness, combativeness, fear, gregariousness or sociability, maternal love, and sex were unanimously regarded as human instincts. Constructiveness, sympathy, rivalry, and secretiveness were mentioned by six authors, and feeding, curiosity, and self-assertion by five. Four authors added hunting, imitation, and jealousy to the list, while repulsion, submissiveness, shyness, modesty, play, walking, cleanliness, and coöperation were mentioned in only three texts. Two authors included vocalization and bullying in their lists, while eleven additional traits were mentioned but once. Of a total of thirty-eight alleged instincts, sixteen were cited by a majority of the authors, while twenty-two received a minority vote. To add to the confusion, certain writers of late have even denied the existence of any instincts in man.

This diversity of opinion is due in large measure to different usages of the term instinct. What aspects of human behavior may be regarded as instinctive will naturally depend upon the way the term is defined.

Definitions of Instinct. — The earlier conceptions contrasted instinct with reason. Rational activities are products of experience, and involve some knowledge of their adaptive significance; they are practically identical with

what we have termed voluntary activity (Chap. XIV). Instinctive activities on the other hand are innately conditioned and function automatically. The conception has two defects: Acquired acts may become so habitual as to function in an automatic fashion, while a person will soon acquire some sort of knowledge of the adaptive significance of his instinctive acts.

According to a very prevalent conception, an instinct is defined as an adaptive act, the first expression of which did not involve any knowledge of its consequences; an instinct is thus regarded as a chain or series of reflexes whose serial organization is a function of congenital conditions. A reflex is defined as a motor response to a sensory stimulus in which the connection between the stimulus and the response is mediated by innate neural conditions. An instinct thus consists of an *inherited* coördination of a number of elemental reflexes in which each response constitutes or furnishes the stimulus for the succeeding response. No complex activity that is adapted to an objective situation can be instinctive according to this definition.

An organism must *sense* an objective situation and respond to those sensory stimuli in order to adapt to that situation. It thus follows that in reacting to a situation the reflexes that are evoked and the order of their appearance will necessarily be determined in large measure by the character of that situation and not by any congenital conditions of the organism. For example, a rat is confronted by a latch box containing food. The wire door of this box is electrically charged and its wooden sides are banked with sawdust. The rat at first responds to the odor by running toward the food and coming into contact with the wire door. The resultant electrical shock evokes an avoiding reflex and the animal explores along one side

of the box and comes in contact with the sawdust. This contact stimulus now elicits the burrowing reaction which is continued until the hard floor is reached, and this stimulus now evokes a new response. The presence of the sawdust was necessary to elicit the digging response, and it is quite apparent that the order in which such a series of reflexes is evoked will depend in large part upon the spatial arrangement of the stimulating objects.

The courting and mating activities of the male pigeon consist of a great variety of reflexive responses such as bowing, cooing, preening, wagging wings, spreading tail feathers, strutting, pecking, billing, necking, and charging and driving. It has been observed that not all of these reflexes will appear unless the female is responsive and that the order of their appearance depends upon the character of her reactions. The order in which reflexes are evoked thus depends for the most part upon environmental circumstances. The stimuli involved in any instinctive series of reflexes, *i.e.*, a series in which the order of appearance is determined by conditions inherent in the organism, must be for the most part *intraorganic* sensations, as in the case of the chewing and swallowing responses that are evoked by the presence of food in the mouth. Organized series of reflexes of this sort constitute but a small part of man's repertoire of reactions.

A third conception regards as instinctive any adaptive reaction which is composed entirely of these congenital reflexes. The order in which these reflexes appear is regarded as unimportant. The order of appearance may thus vary with environmental circumstances as in the case of the nest-building and mating activities of birds. According to this conception, general attributes of specific acts like pugnacity, aggressiveness and perseverance can not be

instinctive although they may be natively conditioned. Such attributes are not instincts because they can not be resolved or analyzed into a coördinated group or series of reflexes. Perseverance is not an act but a characteristic of a great variety of acts. It is the act itself and not its attributive characteristic that is composed of sensori-motor elements. Strictly speaking, man exhibits no instinctive reactions according to this definition, for it is now generally admitted that every adaptive response in man necessarily comprises a considerable number of acquired constituents. Those that subscribe to this belief may be grouped into three classes. First, there are those who adhere to the definition and hence deny the existence of human instincts, — an attitude which in no way disposes of the fundamental problem as to the extent to which the nature of a man's acts is a function of his native constitution. Others apply the term instinct to all adjustive activities which are composed in the main of reflex elements, and use the term habit to refer to all acts which consist wholly or mainly of acquired elements. The distinction between habits and instincts is thus largely a matter of personal opinion. Finally, there are those who adopt a radically different conception of the nature of instinct.

In the final view, just mentioned, the term instinct is not applied to acts. It is used to refer to certain native conditions within the organism which specifically determine the character of its reactions. Each instinct thus reveals or manifests itself through a corresponding act or group of acts and the adjective 'instinctive' is usually employed to refer to these acts. Expressions of maternal love are instinctive reactions which are due to a maternal instinct. An instinct is thus a hypothetical set of conditions whose existence is assumed in order to give an adequate

genetic account of certain observable characteristics of human behavior. Adherents of this view differ considerably as to the nature of these congenital conditions. To some, instincts are merely neural propensities (p. 334). Others apparently identify instincts with what we have termed the various innate motivating conditions such as the bodily appetites of hunger and sex. Instinct, to others, includes all those bodily conditions which we have listed under the term of native preferences and propensities. Popular writers often employ the term to refer to any set of native conditions, — *capacities* as well as propensities. Such writers are accustomed to assert that, although we undoubtedly learn to walk, yet the capacity to walk is instinctive or born within us. With such a conception, it is evident that all human reactions including thinking, reasoning and will are instinctive, for no one can perform an act unless he is born with the capacity to do so. With such a usage, the term loses all of its distinctive value. Finally, one writer has recently asserted that there is but one instinct, and apparently this instinct is the life process itself. What aspects of human behavior are regarded as instinctive will thus depend upon the way we define the term instinct.

Instinct not a Useful Concept. — The value of the term instinct for human psychology may be questioned. This text has practically dispensed with its use. Several considerations may be cited to justify this procedure. We may first mention that the term lacks any well-recognized or standard meaning, and it is quite obvious that the use of a term like this should be avoided so far as possible. Its use also tends to inhibit further efforts towards a more adequate analysis of the act in question. For example, the incubation activities of birds are periodic. A hen will incu-

bate a nest of eggs at one time and not at another. Her responsiveness to the nest of eggs is thus due to the periodic appearance of some set of predisposing organic conditions. Students are apt to think that they have given an adequate account of the phenomenon of incubation when they label it an instinct, whereas a knowledge of the detailed nature of these predisposing organic conditions is really essential to any thorough understanding of the bird's behavior. In explaining any act, the term instinct is thus likely to be employed as a cloak to hide our ignorance of the causal conditions involved. As previously noted, the term has no distinctive value when it is applied to all native conditions, — capacities as well as propensities. Again, if the term is restricted to a particular group of native conditions such as nervous dispositions, we may raise the further question as to whether as a matter of practical procedure it is always possible to distinguish between the instinctive and the non-instinctive components of our congenital equipment. In this connection it is well to note that the methods and devices that are usually employed for the isolation of instinctive traits will also serve equally well to identify any native trait. In fact, the alleged characteristics of instinctive activities which are usually employed in their identification are those which we have already listed under the general topic of the criteria of native traits. Finally, a restriction of the term to certain native conditions raises the question as to whether this differentiation between the instinctive and the non-instinctive elements of our congenital equipment will serve any useful purpose, — a question which we shall discuss in connection with the subsequent topic.

Reasons for Isolating Native Traits. — The previous discussion has assumed that the separation of the native and

environmental influences in mental development will serve some useful purpose. We shall now question this fundamental assumption with a critical examination of the various arguments that are usually offered in its support.

It is said that a complete inventory of man's congenital equipment will give us a knowledge of the *universal* characteristics of human nature and thus enable us to deal effectively with any individual irrespective of the race and cultural group to which he may belong. This doctrine erroneously assumes that all universal characteristics are native and vice versa. Moreover, it is the universality of the trait and not its native character that is important for this particular purpose, and hence the further question as to whether a universal trait is native or acquired is a matter of no concern.

Any fixed order of mental development in children is assumed to be a function of a corresponding series of organic changes incident to bodily growth, and it is asserted that a knowledge of these congenital features of mental development will be of considerable service to teachers in enabling them to adapt their educational procedures to the changing needs and interests of the child. Again, we do not know that all of these stages of development are congenitally conditioned, and such knowledge if obtained would be of no material service to the teacher. All that the teacher needs to know is the exact order in which the mind of the child develops, and for her particular purposes it is wholly immaterial whether this order is congenitally determined or whether it is a necessary incident in the growth of experience.

A very popular doctrine assumes that whatever is *natural* is good, and hence that man's natural tendencies and proclivities furnish a clue to what is right and proper

in social and individual development. This appeal to Nature has been extensively employed in times past to support various theories and programs in the fields of ethics, politics, and education. As an illustration of the absurdities involved in the attempt to establish natural norms for human conduct, we may cite the case of a distinguished naturalist who has recently protested somewhat vigorously against the modern ' sleeping porch ' practice on the ground that it is unnatural. In support of this doctrine he cites the fact that bears hibernate in poorly ventilated dens and asserts that man would have been endowed with fat and fur if Nature had intended that he should sleep outdoors like the moose and the caribou. The isolation of our ' natural tendencies ' can hardly be justified with such reasons.

It is said that all natural tendencies must *inevitably* find some expression in the course of mental development, and that it is a useless waste of time and effort to attempt to suppress or eradicate them. Fighting is an instinctive act, and hence any attempt to abolish warfare is doomed to certain failure. For similar reasons it is asserted that society can never hope to eradicate the social evil. It is well to note, however, that society has made no better progress in eliminating a number of other human vices such as theft, deceit, dishonesty, hypocrisy, and ingratitude, and this fact naturally suggests that we must either regard these traits as instinctive or admit that the congenital character of a trait is not an index of the degree to which it is subject to human control. The statement is frequently made that the attempt to suppress an instinctive tendency is responsible for its abnormal manifestations. Sex vices and perversions are usually cited as examples. However, such social control as is exerted upon the instinctive reactions of anger and fighting does not

seem to be attended with any serious consequences, while the stern denial of some of the acquired desires of a youth does often exert some undesirable effects upon his subsequent development. Perhaps the evil consequences are due to the *method* of control that is employed. At least, as a general principle of interpretation, the doctrine must be viewed with suspicion.

As a matter of fact, a knowledge of the innate or acquired character of any trait gives very little information concerning the possibilities of its control. For the control of any trait, a somewhat detailed knowledge of the various factors that influence its development is requisite.

1. For this purpose we need to know, not to what extent a trait is environmentally determined, but the extent to which it is dependent upon those features of the environment that are susceptible to human control. In this connection it is well to recognize that man's ability to control his environment is extremely limited. Parents can determine to some extent the kind of social environment in which they shall rear their children, but even then it is obviously impossible to exercise any rigid control over the character of the social contacts which their children obtain through the radio, advertisements, motion pictures, newspapers, and companions. No parents can ever make a social environment to order.

2. For purposes of control, it is also desirable to know to what extent any trait is dependent upon various acquired organic conditions due to injuries, poor hygienic habits, malnutrition, infectious diseases, etc. (p. 261), and in this event it is necessary to know to what extent and by what means such effects can either be prevented or remedied.

3. We also need to know to what extent the influence of

any congenital factor can be modified by training. As is well known, fear and anger are susceptible to a considerable amount of modification. By means of training, a person can overcome to some extent the handicaps of congenital blindness, but no amount of training will ever transform a natural bass voice into a tenor, or make an accomplished singer of a person endowed with a defective capacity to discriminate pitch.

4. There are certain congenital conditions influencing mental development which can be remedied or improved by the adoption of proper medical and hygienic measures. Constitutional weakness, defective eyesight, and congenital syphilitic infections may be cited as examples.

5. It is highly probable that many cases of defective development in children are due to the chronic alcoholism and the venereal diseases of their parents. Idiocy, feeblemindedness, degeneracy, and certain cases of insanity can often be traced back to such sources. Obviously the transmission of such characteristics can be prevented by medical and hygienic means.

6. There are other congenital conditions which are *germinally* transmitted, and for their control a knowledge of the laws of biological inheritance and the adoption of eugenical measures are essential. From this discussion it is quite apparent that the mere statement that any trait is either native or acquired gives us but very little serviceable information from the standpoint of social control. To be of service, such information must be supplemented by some detailed knowledge concerning the particular conditions involved.

An instinct is often regarded as a more effective and dynamic *motive* than is any acquired interest. According to this doctrine it is advisable, in attempting to influence

the actions of others, to appeal to some instinctive interest whenever possible. This procedure can probably be justified when dealing with young children who have as yet developed no very dynamic system of acquired interests. A man's acquired interests, ideals, and hobbies often constitute, however, the dominating features of his life. The wily promoter is usually not much concerned with the instinctive interests of his victims unless this term be stretched so as to include the almost universal desire to get something for nothing.

A very popular doctrine asserts that instincts are the *reservoirs of energy* which furnish the motive power that is expended in all of our acquired systems of reaction. They are characterized as the springs to all human action, as the ' driving mechanisms ' of life without which our habits would cease to function. Any interpretation of this doctrine that assumes that the human organism, without instincts, would become inert and cease to act at all does not deserve any serious consideration. As developed in a previous chapter (p. 69), any sensitive organism living in a world of continual stimulation will of necessity exhibit some sort of activity. There is no need to postulate a system of instincts or even a special instinct of activity to account for the patent fact that all organisms exhibit some form of activity just as long as they are alive.

According to the only legitimate interpretation of this doctrine of drives, instincts must be regarded as directive conditions which account for *what* we do. This conception assumes that all our acquired modes of reaction have been developed from and continue to be motivated by our system of instincts. Instincts thus determine the *direction* of individual and social development. In metaphorical terms, instincts can be likened to the banks of a river in the

sense that they determine the course of the stream of mental events. If we should change the character of a man's instincts, we should likewise change the character of all the interests, ideals and habits which he has acquired in the course of experience. With the loss of our instincts, all our present systems of habit would soon cease to function, but we should nevertheless continue to react in some sort of a fashion. Instincts can thus be regarded as 'drives' only in the sense that they compel us to keep reacting in the particular ways in which we now do. This doctrine is valid, however, only for that conception of instinct which uses the term to refer to the innate motivating conditions of the organism. Motives arouse and dominate the activity of an organism until it succeeds in reacting in such a way as to satisfy those motivating conditions (p. 73). All forms of human endeavor, individual and social, must finally be evaluated in terms of their success or failure in satisfying the fundamental needs of the organism.

The above doctrine must be qualified in certain respects before it can be accepted. Not all motives exert a distinctive effect upon the course of individual and social development. For example, all animals exhibit a natural preference for a certain bodily position in reference to the earth, and when turned over and placed upon their backs, they immediately attempt to right themselves. However, the satisfaction of this natural preference does not constitute one of the persistent problems of life, for most organisms are able either to maintain their normal position or to right themselves with but little effort. Likewise, man's need for air is automatically provided for, but let us suppose that the environmental conditions were such that air, like water, must be sought, stored, purified, and distributed.

In this case the continual satisfaction of this motivating need would constitute one of the persistent problems of life, and the attempt to solve this problem would exert a very profound effect upon the industrial organization of society.

It is thus evident that we must account for the nature of man's individual and social development primarily in terms of the fundamental problems of life with which he is confronted, and we must not assume that the character of these problems is exclusively a function of the motivating needs with which man is endowed. A motivating need constitutes but one of the essential factors of every problematical situation. The existence of problems is just as dependent upon many other features of our congenital equipment such as our sensory and motor ability. Problems likewise depend upon environmental circumstances. Given constant climatic conditions of the proper sort, man would no longer be confronted with the problems of heat and shelter. In other words, the character of human development can not be adequately accounted for in terms of instinct or any other limited group of congenital factors. For this purpose we must envisage the entire congenital equipment of the organism from the standpoint of its relations to environmental conditions.

Although we may discard the concept of instinct and admit the practical difficulties involved in evaluating the relative influence of heredity and environment in the development of many human traits, yet the student must not lose sight of the obvious fact that man's development is to a large extent a function of his congenital endowment. Undoubtedly, the dissimilarities of human and animal development are largely determined by differences in their congenital equipment, although we may be unable to specify

in any exact manner the detailed nature of these differences. However, the fact that heredity is largely responsible for the differences between animals and man does not justify the assumption that the diversities of human development can be accounted for in a similar manner.

EXERCISES

1. Is it possible to eliminate entirely the influence of the environment in human development? Is it possible to rear two human individuals under environmental conditions that are different in every respect? Is it possible to rear two children so that they will have identical environmental contacts? Will differences of congenital equipment necessarily involve differences of environmental contact?

2. Why is the separation of environmental and congenital influences more difficult with man than with animals? Why is it more difficult with the higher than with the lower animals?

3. Apply the various alleged criteria of native characteristics to maternal love, curiosity, gregariousness, modesty, walking, racial prejudice, hypocrisy, and deceit.

4. Make out a similar list of the criteria of an environmental characteristic.

5. What attitude would you take toward the instinctive character of rivalry, jealousy, and play as you adopt each of the various definitions of instinct that have been suggested?

6. What practical difference would it make in our social, political, and educational policies if we knew that wars, racial prejudices, religion, modesty, and dishonesty were the expression of natural proclivities?

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CHAPTER XVII

THE MEASUREMENT OF ABILITY

Individuals differ quite widely in ability. The genius and the idiot represent the two extremes of individual difference in this respect. Moreover, people invariably make some sort of estimate of each others' ability and govern their actions in accordance with this estimate. For example, every executive, in selecting employees for any type of work, is necessarily concerned with the relative ability of the applicants. We seek legal, medical, or business advice only from those whom we deem competent to give it. Practically all of our reactions toward people are influenced to some extent by our judgments of their ability.

The Value of Measurement. — Measurement serves the same purpose as estimations, but in a more effective fashion. For example, we can either estimate or measure the distance, size, or weight of an object. Estimates naturally vary with the individuals who make them. Measurement is a method of evaluating things in impersonal, objective, and standard terms. Measurement is thus the more reliable and accurate method of evaluation. A number of people can measure the same thing and obtain similar results. It is thus evident that any simple and reliable scheme of measuring individual ability would necessarily be extremely serviceable for both practical and scientific purposes. In fact, the attempt to devise and improve methods of measuring human ability represents one of the dominant tendencies of psychology in recent years.

Ability and Performance. — Our estimation of an individual's ability is primarily based upon a typical series of his best performances, and the concept of ability is useful in predicting what that individual will do under *favorable* conditions. As is well known, an individual's achievements frequently fall far below the level of his ability. We must not assume, however, that ability has no relation to performance. In fact, the term ability has no meaning except in terms of achievement and performance. The concept is derived from and refers to an individual's typical performances under favorable circumstances.

It follows that we can measure a person's ability most directly and accurately by obtaining a typical series of records of his best performances. To this end it is necessary to secure a record of an individual's performances in a given task when he is feeling mentally and physically fit, when he is free from all unusual distractions, and when he is given sufficient inducements to do his best work. Records of performance in a given task, when secured under favorable circumstances, constitute the most direct and most accurate means of measuring a person's ability for that type of work.

Ability Varies with the Task. — In attempting to measure the ability of any individual, we are immediately confronted with the significant fact that a person's ability varies with the task. It is a common-place observation that a high degree of scholastic ability may be coupled with a very mediocre ability for many of the more practical concerns of life. A man may have a high degree of executive ability and but little musical or artistic ability. Likewise a good salesman may make a poor mechanic, and a good accountant may be a failure in the field of politics An ability for fine sensory discrimination is not necessarily correlated with

a high degree of motor dexterity, and neither does intellectual ability presuppose a corresponding amount of volitional effectiveness. In other words, a person possesses not one but a great variety of abilities, and we may be interested in measuring any one or any group of these abilities. In devising and applying methods of measurement, it is thus necessary to specify exactly the particular ability or group of abilities which we are attempting to measure.

Kinds of Ability. — As indicated, abilities may be specified in terms of the task in which the subject is engaged. Clerical, executive, mechanical, musical, and mathematical types of ability are examples. Again, abilities may be specified in terms of the predominant mental processes that are employed. On this basis, we are accustomed to speak of a person's volitional, rational, mnemonic, imaginative, and motor abilities. Finally, abilities may be classified on the basis of their special or general character.

The Concept of General Ability. — Ability for some particular task such as typewriting, accountancy, salesmanship, and mechanics is usually termed a special ability as distinct from a general ability which refers to an individual's average or typical ability for some group of related tasks. However, there are many general abilities rather than one. We may speak of a person's general social, artistic, business, motor, or intellectual ability. The words 'general' and 'special' as applied to abilities are relative terms. Typewriting ability has a certain amount of generality inasmuch as it represents a combination of several more specific abilities, as the ability to write accurately, speedily, or neatly; it also involves the ability to read and spell, and the ability to sit erect and move the hands and fingers in a coördinated fashion. Salesmanship likewise has a certain degree of generality. In speaking of salesmanship, we

usually refer to an individual's ability to sell any kind of goods to any class of customers. A person may be a first-class salesman for automobiles but not for books or life insurance. Again, an individual may be successful in selling to housewives but not to laborers or business men. Salesmanship, however, is a relatively specialized ability as compared to what we call business ability.

There are thus all kinds and degrees of general ability, and it is permissible to speak of a person's *ability*, as distinct from his abilities for this and for that, only when we refer to the most general kind of ability. However, when we speak of a person's ability in this unrestricted and unspecified manner, we do not refer to his average ability for all sorts of tasks but only for that group of tasks which society regards as relatively the most important. In estimating an individual's ability, we base our judgments primarily upon his intellectual qualities, his temperamental traits, and his volitional characteristics, and ignore his sensory, and motor, and artistic abilities because we regard them as unimportant for this particular purpose. In measuring ability it is necessary for the most part to specify quite carefully the kind of ability with which we are concerned.

Tests of Ability. — The device employed in measuring ability is usually called a test. A test consists of some standard assortment of tasks or exercises of such a character that the subject's performance in these tasks can be conveniently, reliably, and accurately scored in numerical terms. The score usually represents the number of correct responses or answers given in a prescribed interval of time.

There is no one standard test that can be employed in measuring ability. The nature of the test necessarily varies

with the age or development of the subject, the kind of ability to be measured, and its specific or general character. A test designed to measure intellectual ability in children will be less difficult and complicated than that employed with adults. A test adapted to measure memorial ability will differ from that designed to measure general intellectual ability, and tests adapted to the measurement of musical ability will differ radically from those employed in measuring mechanical ability, intellectual ability, or executive ability. Just as many kinds of test are needed as there are types of ability to be measured, and for this reason the nature of tests can not be described in any detail. Each particular sort of test must be described separately.

Tests of Intellectual Ability. — For purposes of illustration, we shall give an example of some of the various types of exercise that are generally employed in measuring intellectual ability.

1. The subject is presented with lists of words such as rough, doubtful, expand, silly, reckless, and enthusiastic, and for each of these words he is requested to give a word of the opposite meaning, *viz.*, smooth, certain, contract, sensible, cautious, and apathetic respectively.

2. The words composing a sentence are disarranged, and the subject is asked to rearrange them in their proper order. The words 'many toes fingers as men as have' can be rearranged into the sentence 'Men have as many fingers as toes.'

3. Several words are omitted from a sentence, and the subject is required to complete the sentence by writing the appropriate words in the blank spaces provided for this purpose, as in the following example: The boy —— an apple, —— when he saw —— was decayed, he —— it ——.

4. Another type of exercise requires the subject to fill in the missing items in a series of related numbers, as in 2, 5, 8, —, 14, 10, —, 2.

5. As an illustration of another type of exercise, the subject is requested to underline that word of the five contained in parenthesis which bears the same relation to fork as soup does to spoon: Spoon — Soup: Fork — (Plate, Cup, Knife, Meat, Crackers).

6. In another type of exercise, the subject is requested to point out the absurdity involved in some given statement, such as ' The storm which began yesterday has continued for three days.'

7. A final task is designed to test the ability of the subject to follow a series of written directions as in the following exercise:

Cross out the middle letter in the second word of this sentence. Underscore the fourth word of the previous sentence, and the fifth word of the next sentence. Cross out the sixth letter of the first word and the third letter of the sixth word of the previous sentence. Write in here —— the word formed by the three cancelled letters, and write here ———— the last letter of each of the last six months of the year, but leave this space —— blank for the present. Spell here ———— the word ' thirteen ' backward, and then enter in the previous blank the number of times the word ' the ' has been used in this exercise.

Standardized Scales of Ability. — Let us assume that we have subjected an individual to a given test and secured a performance score of 137. This value in itself is meaningless. The value can serve as an index of the subject's ability in the test only when we compare it with similar performance records of a representative group of people. Having secured the performance records of a thousand

individuals, we arrange them according to the size of their scores, divide them into a number of groups of equal size, and compute the average score for each of these groups. The number of these groups is determined arbitrarily. We may divide our thousand individuals into 2, 4, 10, or 100 groups to suit our own purposes. In general, the larger the number of groups, the finer will be the quantitative comparisons we are able to make. Let us assume a division into ten groups with average performance records ranging from 54 to 137. We may now say that our individual with a test score of 137 has an ability (for this test exercise) which is equal to the average ability of the best 10 per cent of our standard group of one thousand individuals. Measurement of an individual's ability for any task thus presupposes a standardized scale of abilities for that task, and this scale can be furnished only by the performance records in that task of some *representative* or *standard* group of people.

A standard or representative group of individuals must fulfill two conditions: (1) Its members must be chosen at random from some larger homogeneous group of a specified character (unless the whole group be selected), and (2), it must be of such a size that the distribution of its scores will be approximately duplicated by any other random selection of an equal number of individuals from the larger group. The performance scores of such a selected group constitute a standard scale of values because this scale can be duplicated at any time by any other person. The selected group may also be regarded as a typical sample or representative of the larger group for the same reason.

The character of the selected group will vary with the ability and the purpose of measurement. In devising a test to measure the ability to sell automobiles, the standard

group should be selected from automobile salesmen representing all degrees of ability. In measuring general sales ability on the other hand, the group should be so chosen as to be representative of salesmen in general. In dealing with the scholastic ability of a ten-year-old child, we should naturally wish to compare him with a representative group of his own age and educational opportunities. If our interests are more scientific and we wish to evaluate the relative intelligence requisite for success in the various trades, occupations, and professions, the standard group must be chosen from the adult population at large.

As a matter of fact, the scores of any selected group will never be exactly duplicated by those of any other similarly selected group. No such group will ever be wholly representative in character. In general, the larger the group relative to that from which it is selected, the more standard and representative will be the scale of values obtained. In actual practice, experimenters are usually content with a group of such a size that their scale of values can be duplicated with a reasonable degree of accuracy, — a degree of accuracy that is sufficient for all practical purposes. The number of individuals that must be included within the group in order to secure a given degree of accuracy can not be predicted in advance inasmuch as their number is a function of the variability of their scores. However, a statistical formula has been devised that enables one to predict the probability with which the scale of values obtained from a given group can be duplicated with the required degree of accuracy.

Test Scores as Indirect Measures of Ability. — Having secured the test score of an individual and compared it with our standard scale of values for this test, we have so far obtained merely an accurate and *direct* measure of that

person's ability to do this type of work. In other words, we have directly measured his test ability.

No one, however, is primarily interested in test scores as indices of test ability. Test scores are significant only as *indirect* measures of some practical kind of ability, — mechanical, intellectual, musical, or executive ability, and we have now to consider the conditions under which test scores can be utilized as indirect measures of some other ability or group of abilities.

Let us suppose that we wish to utilize test scores as a measure of the ability to sell automobiles. We select a representative group of such salesmen, including those who have failed as well as those who are successful, and from a study of their actual records in selling automobiles, we obtain a series of values typical of their best performances, which values constitute a direct and accurate and unambiguous measure of their ability to sell this type of goods. We now submit our test exercises to this group of salesmen and obtain a similar series of test scores. If there is a perfect correspondence between the two series of values, *i.e.*, if the position of any individual's score in the test series is invariably duplicated in the series of sales records, then the test scores may thereafter be utilized as an indirect but relatively accurate measure of the sales ability of a similar group of prospective salesmen. If the two series of values exhibit a certain degree of correspondence, the test scores may be regarded as an imperfect index of sales ability, the accuracy of which is roughly proportional to the degree of correspondence. Finally, the absence of any degree of correspondence will indicate that this test can not be used as an indirect measure of this particular ability.

Several statistical formulas have been devised to enable one to state in numerical terms the degree of correspond-

ence obtaining between any two such series of scores. This numerical value is termed a coefficient of correlation. If the two series of scores correspond perfectly, the coefficient will be 1.00. If there is no correspondence between the two series, a value of 0 will be secured. Given a certain degree of correspondence, a value intermediate between 0 and 1.00 will be obtained, the size of which will vary with the degree of correspondence. In other words, the size of the coefficient obtained is an index of the degree of accuracy with which the test scores measure the ability in question.

Having discovered in this empirical manner that our selected test does measure with some degree of success the ability to sell automobiles, we may now apply it in a similar manner to various representative groups engaged in selling other kinds of merchandise, and likewise discover whether the test is adapted to measure any kind of sales ability or whether it can be used only as a means of measuring the ability to sell some particular kind of goods. Again we may apply it to a representative group of executives and to a representative group of business men, and discover in a similar manner whether it will also measure executive ability and general business ability or whether its use must be limited to the measurement of salesmanship. In general, a test can be used as a measure of any ability with which it correlates. We can not legitimately employ any test as a means of measuring a given ability unless the fact of their correlation has been previously demonstrated. The fact can not be too vigorously emphasized that no one is justified in making any final or conclusive statement concerning the range or kind of abilities which any particular test measures except upon the basis of empirical correlations.

Our previous statement that the size of the coefficient of

correlation is an index of the accuracy of the test measurement must now be qualified in one respect. In comparing two series of values which give a correlation coefficient of .50, we may discover that the degree of correlation is not uniform throughout the series. For example, the higher test scores may correlate almost perfectly with the corresponding performance records, while the lower values exhibit practically no correlation at all. In this event, it is evident that the test scores can be utilized only as a measure of the higher grades of the ability in question. In order to determine the grades of ability which the test will measure, it is first necessary to plot the two series of values and discover the extent and kind of correlation which they exhibit.

So far tests have been perfected for the measurement of a restricted number of abilities. A test of musical ability has recently been devised that has given very satisfactory results. Tests have also been standardized for the measurement of a considerable number of trade and occupational abilities, such as tests for carpenters, clerks, printers, and machinists. A large number of satisfactory tests have also been perfected for the measurement of scholastic and general intellectual ability. All of these tests, even the most satisfactory ones, are far from perfect. As previously stated, an individual's performance record in a given task, when obtained under favorable circumstances, furnishes the most accurate and unambiguous index of his ability for that type of work, and the accuracy with which a test will indirectly measure the same ability is roughly proportional to the degree of correlation obtaining between the test scores and the performance records. As a matter of fact, it is quite unusual to secure a correlation between test scores and the corresponding performance records that is

higher than .70. In other words, no test so far devised ever indirectly measures an ability with any very high degree of accuracy.

Direct Measures of Ability. — The use of test scores as an indirect measure of any ability presupposes that this ability has been directly measured for some representative group of individuals. Abilities can be directly measured in several ways.

1. The relative efficiency of a group of individuals in certain tasks can be measured in terms of their production records. Such a method can be utilized in many types of manufacturing operations such as lathe work. Likewise the amount of goods sold can be used as an index of the efficiency of salesmen as in the case of our example of measuring the ability of a group of automobile salesmen.

2. It is manifestly impossible to keep a set of performance or achievement records for certain tasks such as clerical work. In such cases, the conditions of work from time to time may be so arranged as to secure a typical series of sample records, and these sample records may be used as a measure of the individual's efficiency in the task. Any such standardized procedures that are arranged for the purpose of checking up the relative efficiency of a group of workers may be called performance or achievement tests. As an illustration of this method of measuring efficiency, we may cite the use of written quizzes and formal examinations in our schools.

3. Finally, an individual's efficiency in other types of task is of such an intangible character that it can not be measured in objective terms. The method of estimates must be employed in such cases. The relative efficiency of a group of individuals is rated by several competent judges on the basis of their observations of the performances of

these individuals. For example, oratorical and debating contests are decided in this manner. Ratings by principals and supervisors are generally employed as a means of measuring teaching efficiency. Any systematized and standardized procedure for obtaining and combining such estimates is usually known as a rating scale. The method is capable of an extensive use in the fields of business and industry, but as a general rule the employment of this method is not advisable when the efficiency of an individual can be measured in objective terms.

The tests that are used as indirect measures of ability sometimes differ but little in character and content from the performance tests that are employed in directly measuring an ability. The two kinds of test differ primarily in the purpose for which they are used. Performance tests are employed to measure an individual's proficiency after he has been assigned to a task. Indirect tests of ability are predictive devices; they are employed as a means of determining an individual's fitness for some specified task before he is assigned to it. The performance scores in any given task may thus be utilized as a direct measure of an individual's ability for that task, or they may be used as an indirect means of determining that individual's fitness for promotion to some more difficult task. This chapter is primarily concerned with the use of tests as indirect measures of ability.

The Economy of Test Measurements. — The fact that an individual's ability for any task can be measured more accurately by performance records than by means of tests naturally suggests the question as to why tests should be employed for this purpose. The question may be answered by the statement that test measurements have

a value in spite of their inaccuracies, and this value is one of *economy*.

For purposes of illustration let us suppose that a manufacturing firm finds it necessary to employ ninety operatives for each of two tasks involving different degrees of ability. Previous experience has also indicated that one-third of all applicants lack the requisite ability for either task and but one-third possess the necessary ability for the more difficult job. The firm now hires two hundred and seventy applicants, who are divided by chance into two equal groups, and each group is assigned to one of the tasks. The fitness of these applicants for the jobs to which they are assigned is now determined on the basis of an extensive series of performance records. According to chance only one-third of those assigned to the more difficult job will possess the requisite degree of ability; ninety of this group will need to be transferred to the less difficult operation. Finally of all those tested on the less difficult job, ninety will prove unfit for either task and be discharged. In other words, one hundred and eighty of the applicants will fail at one or both of the jobs to which they were assigned. Because of the large number of failures, such a method of selection will be rather expensive. It will involve the cost of supervision and administration, a lessened rate of production, and a wastage of raw materials, as well as injuries to tools and machinery.

Let us suppose that a test has been devised which is known to give a high degree of correlation with the ability in question. The group of applicants are first subjected to the test and, on the basis of the scores obtained, let us suppose that seventy of the poorer ones are forthwith rejected. The remainder are then distributed on the two jobs in accordance with their test scores. On the basis of their

subsequent performance records, we will assume that fifteen of those assigned to the difficult task will need to be transferred to the less difficult one, and that twenty will need to be discharged because of a lack of ability for either job. We have then a total of thirty-five misfits as compared with one hundred and eighty by the former method. It is thus easy to see that the use of the test method may institute a saving of several thousand dollars.

Again, people who are contemplating a musical career usually base their judgments concerning their ability for this type of work upon the progress they attain during several years of intensive training. Needless to say, this method of ascertaining one's ability is an expensive one, and any test that selects the musically incompetent with a reasonable degree of success would be extremely serviceable. As a matter of fact, a test has been devised for this purpose which is said to give very satisfactory results.

Test devices when used as indirect measures of ability thus constitute a very simple and convenient means of securing some relatively accurate *advance* information which can be used advantageously in classifying, selecting, and placing individuals in accordance with their ability. Tests enable us to predict with some degree of accuracy what an individual can do in a given situation. Tests conserve either time, energy or materials, and it is quite obvious that, other factors being equal, the economical value of a test will be proportional to its accuracy. Tests can not always be advantageously employed. The two factors of economy and accuracy must be considered in deciding whether a test should be employed for any particular purpose. In selecting day laborers, for example, the resulting economy may be so slight that the use of a test would hardly be justified even though this ability were measured with a

high degree of accuracy. On the other hand, the economical value of a test for a certain task or occupation may be so great as to justify its use even though it is relatively inaccurate for this purpose.

All classifications and selections of individuals on the basis of their test scores must always be revised in accordance with their subsequent performance records. It is necessary to emphasize this point because the tacit assumption is often encountered at present that tests are scientific and hence somewhat mysterious and highly accurate means of predicting the true ability of an individual, and consequently their results must be accepted without question even though these results may conflict with the individual's subsequent performance records. It is needless to state that this pernicious assumption is wholly unjustified. Performance records secured under favorable conditions constitute the most accurate index of an individual's ability for the task in question that can be obtained. The only reason why typical test scores do not correlate perfectly with a typical series of performance records is the fact that the test exercises and the task which they are supposed to measure involve somewhat *unrelated* groups of ability.

The Relative Value of Test Measurements. — The value of test devices for classifying and selecting individuals for any given purpose must always be compared with that of other means of doing the same thing. In our previous illustration of selecting qualified operatives, it will be noticed that the accuracy of the test method was directly compared with that of a chance selection, and we concluded that the test was the more accurate of the two methods. The reader must avoid the assumption that the use of tests is legitimate whenever they give more accurate results than does a chance selection, for there may be other available

selective devices that are superior to tests. In other words, the use of tests as a means of obtaining a provisional classification and selection of individuals in respect to some ability can not be justified unless we know that these test devices are more accurate, convenient, or economical means of accomplishing this result than is any other available method.

As a matter of fact, various selective devices are frequently used. Employers often make their selections on the basis of priority of application, amount of previous experience, character of testimonials, amount of school training, personal impressions obtained from interviews, etc. It is quite obvious that no one would be justified in urging an employer to adopt the test method unless it can be shown that this method is superior to the one in use. It has been proposed that tests of scholastic ability be adopted in the place of entrance examinations and high school records as a means of admission to college. This proposal naturally raises the very crucial question as to the relative value of the three methods.

The value of any other selective device must be ascertained in the same manner as that of tests, *i.e.*, by the empirical method of correlation. The most accurate method will be that which correlates most highly with the ability in question. In other words, any valid statement concerning the relative accuracy with which a test and other selective methods will measure a given ability must be based upon a set of comparative correlation records. Little comparative data of this sort are as yet available. For example, a recent study compared the relative accuracy of entrance examinations, high school records and an intelligence test in measuring fitness for entrance to Engineering Schools. It was found that the customary type of

entrance examination was the poorest method for this particular purpose while the intelligence test and the high school records did not differ in efficiency. An improved form of entrance examination, however, gave better results than did either tests or high school records. These methods must also be compared in respect to economy of administration. Both tests and entrance examinations are quite expensive as compared with the use of high school records as a means of admission. When conducted on the campus, tests and examinations entail a needless expense on the part of the unsuccessful applicants, and even when given at various centres of population, the two can not compare in economy, ease and convenience of administration with the method of high school certification.

In so far as they are accurate measures of ability, tests may be legitimately employed as a *supplemental* means of selection. For example, it has been proposed that tests of scholastic ability be used in conjunction with high school records as a means of admission to college on the basis of the valid assumption that two relatively inaccurate devices are better than either one alone. In considering the value of tests, it is thus necessary to distinguish rather sharply between the use of a test as a supplemental device and its use as a substitute for some other method of selection. Undoubtedly, the use of tests as supplemental devices can be justified for a great variety of purposes.

The Binet-Simon Tests of Intelligence. — The most widely known type of test is that of Binet and Simon, of which there have been many revisions and modifications. Such tests are extensively used in our schools and juvenile courts and institutions. The one generally employed in this country is known as the Stanford revision. It consists of groups of simple exercises of varying degrees of diffi-

culty, — one group for each year of chronological age development. The exercises were so selected that each group of tasks can be satisfactorily solved by approximately fifty per cent of a representative group of children of the corresponding age.

For example, the exercises for six-year-old children involve the ability (1) to distinguish between right and left in terms of eyes, hands, and feet, (2) to detect an obvious omission from a picture, (3) to count thirteen objects, (4) to name four common coins, (5) to repeat a spoken sentence containing sixteen syllables, and (6) to give a valid answer to some simple problem of conduct that is orally suggested.

For nine-year-old children, the exercises involve the ability (1) to repeat three digits in the reverse order from that in which they were given, (2) to construct a sentence containing three specified words, (3) to give within a minute three words that rhyme with the one presented, (4) to name the months of the year, (5) to solve simple arithmetical problems involving the making of change, and (6) to arrange in order of weight five objects that are identical in appearance.

A child is now subjected to these groups of exercises in the order of their difficulty until the limit of his ability is reached. A child that can satisfactorily solve all the exercises of each group up to and including that for ten years is said to have a mental age of ten, and likewise a child will have a mental age of eight when he is able to answer satisfactorily all groups of exercises below that for the ninth year. As a matter of fact, a child is usually able to answer correctly a few of the exercises of those groups which lie beyond his maximum limit. It is customary in actual practice to allow a certain amount of credit for these extra

answers, and consequently the mental age of a child may be stated in terms of years and months.

The mental age of a child indicates the degree of his development, measured in terms of these test exercises, as compared with the average ability of a representative group of children of his own chronological age. Children whose mental age is the same as their chronological age are normal in ability. A child of ten with a mental age of twelve is thus superior in ability to the average child of ten years, while a child of nine with a mental age of seven is two years retarded as compared with those of his own age.

The term ' intelligence quotient ' is used to characterize the relation of a child's mental and chronological ages. The intelligence quotient is the percentage ratio of mental age to chronological age. A child of ten with a mental age of eight has an I.Q. of 80, and a child of the same age with a mental age of twelve has an I.Q. of 120. An I.Q. of 100 indicates that the child has a mental age which is equal to that of the average of a representative group of children of his own age. One must avoid the common tendency to regard the I.Q. as an entity or thing. The I.Q. is merely an index of the amount or degree of development per unit of time; it may thus be regarded as a measure of the *rate* of development of this test ability.

The mental ages or test scores may be utilized as indirect measures of all abilities with which they are known to correlate. It has been found that the test scores correlate reasonably well with teachers' estimates of their pupils' intelligence, and consequently they may be regarded as a fair measure of whatever we ordinarily mean by the term ' intelligence.' The term ' intelligence test ' finds its only justification in this fact. The scores also correlate fairly well with quality and amount of school achievement and hence are

measures of scholastic ability. In fact the test was devised primarily as a means of measuring the scholastic ability of elementary school pupils. It will be noted that many of the test exercises such as distinguishing between right and left, naming coins, and arranging objects in order of weight involve types of knowledge and skill that are not specifically taught in school but which the child necessarily acquires in the process of adjusting to his wider social environment. Presumably, then, a mental age score will indicate the amount of progress which a child has made in adjusting to the cultural conditions of his social group, while the I.Q. may be regarded as an index of this type of adaptive ability. As a matter of fact this presumption has been reasonably well justified by the success that has attended the use of the test as a means of detecting those who are deficient in this respect.

The Doctrine of Native Intelligence. — As previously stated, the Binet test is usually called a test of intelligence, and, furthermore, it is said to measure a child's innate or constitutional ability. This assertion raises in a concrete form the general problem — discussed in the preceding chapter — as to the relative influence of the native and environmental factors in mental development. The doctrine of native intelligence, however, is so widely accepted and is fraught with implications of such practical and theoretical importance that it deserves a thorough critical examination.

No one maintains that the actual knowledge and activities employed in answering these test exercises are inherited. Obviously, all of these reactions have been acquired in the course of experience. Neither can we say that the ability of a child as revealed by the test at any given time is native in the sense that this amount of ability was present at birth, for the mental age of a child, which is the index of his de-

gree of ability, increases with his development. The ability is one that *develops* with age. Neither is this ability native in the sense that its development is not dependent upon environmental influences. Obviously, the growth of this ability, like that of all other developmental characteristics, presumes the existence of some sort of environmental contact; no organism would long survive in the absence of all environmental contacts. The ability is natively conditioned in that we are born with the *capacity* to develop in this manner. This conception lacks any distinctive significance, however, for every developmental characteristic is native in this sense of the term, for man is necessarily born with the capacity for every thing that he does (p. 384). In other words, all development is dependent upon both hereditary and environmental conditions.

The doctrine of native intelligence can mean but one of three things:

1. All individual, group, and racial differences of I.Q. are *wholly* determined by innate differences of constitution, or, in other words, the differences of I.Q. in any group of children are in no wise influenced by the diversity of environmental circumstances that attend their development.

2. Differences of native conditions are *partly* responsible for these differences of intelligent status.

3. The diversities of I.Q. are *mainly* determined by constitutional differences.

The adherents of the doctrine differ in their attitude toward these three possibilities of interpretation, and, again, they differ in their conception of the way these native conditions influence the degree of development.

1. One conception assumes that there are certain fixed constitutional *limitations* to the extent to which this ability is capable of development. For example, organic conditions

obviously limit the speed with which a person can run irrespective of the amount of his training. The strength and endurance of an individual can be improved only up to a certain point. Likewise, there is a limit to the number of items that a person can memorize within a given time, no matter how much this function is trained. Moreover, these organic limitations naturally expand with the growth of the organism. The conception is applicable at least to certain of the test exercises such as the number of items which a child can repeat after one presentation, and the number of responses that can be made in a given interval of time.

2. The second conception assumes that the *rate of improvement* in this ability is dependent upon native conditions. According to this conception, constitutional differences between two children of the same age may be wholly responsible for their difference in mental age, although neither child has actually attained the degree of development of which he is capable. The two conceptions, it is well to note, are not mutually exclusive; in fact, the two sets of conditions may be correlated phenomena.

Three critical comments may be made concerning the concept of constitutional limits as an *exclusive* method of explanation.

1. Some doubt may be expressed as to its applicability to certain of the test exercises.

2. The concept assumes that individual differences of I.Q. can be influenced by native conditions only in so far as the individuals concerned have attained the limits of their constitutional capacity for development, for obviously a limiting condition can affect development only when that limit is *reached*. A limit will thus completely determine the degree of development or else have no effect upon it. In other words, the concept implies that the difference in

I.Q. between any two individuals must be wholly due to a difference of native constitution or to a difference in environmental circumstances.

3. The organic limits to the speed, strength, and accuracy of some types of performance at least are undoubtedly influenced by all environmental circumstances that seriously affect the health of the organism.

Probably no one will seriously maintain that the influence of native conditions upon the development of intelligence can be wholly explained in terms of the concept of ' limits.' The validity of both conceptions must be admitted. No statement, however, can be made as to the relative influence of the two sets of hypothetical conditions.

The assumption that all individual, group, and racial differences of I.Q. are wholly determined by innate differences of constitution must be discarded because of the fact that the I.Q. is often altered during the course of development. It is true that the average I.Q. of a representative group of children remains relatively constant from year to year, but this fact is not particularly surprising or significant inasmuch as the test exercises were purposely selected in order to achieve this result. It has been found, however, that significant changes do occur in approximately ten per cent of the individual intelligence quotients of such a group of children, and it is these individual changes that are significant. There is some evidence that the mental status of a child may be improved by the successful treatment of serious infections of the teeth. The hookworm disease seriously retards mental development, and this effect is alleviated to a considerable extent if the disease is treated in its early stages. The thyroid treatment undoubtedly improves the mental status of cretins, and likewise the I.Q. has been raised by the successful treatment of congenital syphilis. It

is known that rural children on the average test lower than do a corresponding group of urban children, and it has been found that this difference diminishes when the rural children are given the advantages of an urban education. Undoubtedly, the I.Q. is affected in many cases by variations of environmental circumstances, and in this connection it is well to note that our ability to control the mental status of a child may be materially increased with the further development of medical, hygienic, and educational knowledge. Control comes through knowledge, and our present knowledge of child development is extremely limited.

There is indubitable evidence, on the other hand, that many differences of I.Q. are due in whole or in part to differences of congenital equipment. It is known that congenital syphilis may seriously retard mental development. Idiocy, imbecility, and feeble-mindedness often run in families, and the possibility of social transmission is often excluded in these cases by the fact that the mental defect is correlated with certain easily recognizable physical symptoms (p. 372). Moreover, this type of mental defect can not as a rule be materially improved by any form of intensive training.

The facts thus justify the general statement that differences of I.Q. are sometimes due to congenital differences and sometimes to the diverse circumstances that attend development and in other cases both factors may be operative. As a consequence we are now confronted with the third form of the doctrine that asserts that the diversities of I.Q. are *mainly* determined by differences of congenital equipment.

As developed in the previous chapter (p. 378), the relative influence of native and environmental conditions will vary with the pair of individuals or the two groups that

are subject to comparison. The fact that the difference in I.Q. between two defective children is entirely or mainly due to congenital conditions does not warrant the conclusion that the same factor is responsible for the similar difference between two normal children. Likewise the fact that environmental influences are mainly responsible for the difference between urban and rural children in respect to their average intelligence quotients does not justify the assumption that the same factor is responsible for the difference between two groups of city children. No one is justified in inferring that the difference between any two groups of children is due to environmental conditions because it is known that developmental circumstances account for the average difference of I.Q. between a group of normal children and one that is afflicted with the hookworm disease. Especially must we avoid the pernicious fallacy of inferring a native origin for national and racial differences on the basis of individual or group comparisons within a given social unit. No valid generalizations can be made on the basis of a few cases. The relative influence of these two factors in mental development must be independently evaluated for each type of comparison. In other words, the third form of the doctrine must be interpreted to mean that, for all possible individual, group and racial comparisons, the differences of I.Q. are mainly determined by native conditions in a large majority of the cases.

It is evident that we lack at present the requisite knowledge for such a generalization. Furthermore, the difficulties involved in evaluating the influence of the two sets of conditions are practically insuperable in many cases. Especially is this true of racial comparisons. It was found that the ability of our drafted soldiers, as measured by their test scores, varied with their nationality, and that this differ-

ence decreased with the length of residence in this country. On the assumption that these differences are native in origin, the conclusion was made that our recent immigrants have been drawn from a poorer stock than formerly was the case. Such an interpretation ignores the very obvious and equally plausible conception that these differences are cultural in origin. The average test scores of white children are higher than those of Indian and Negro children, but again the possibility of social and cultural influences has not been excluded. It has been found that the test scores of Indian children in a government school correlate fairly well with the amount of their white blood, and this fact has been regarded as a proof of the doctrine that intelligent ability is hereditarily determined. The argument ignores the possibility that the intellectual status of these children was established to a large extent by the cultural and social influences to which they were subjected before entering this school. In comparing different races it is practically impossible to eliminate the influence of cultural differences. As a crucial test, let us assume that a negro child is adopted at birth by a white family and never comes in contact with any member of his own race. Apparently, the possibility of differences of cultural and social influence has been thoroughly excluded by these means. As a matter of fact, however, the associates of this child will not react to him in exactly the same manner as they do to a child of their own color, and these differences of mental attitude and behavior will in turn profoundly influence the character of his reactions to his social environment.

Finally, these test scores will justify no dogmatic statements concerning racial differences of adaptive ability in general, — irrespective of its native or acquired character. The test exercises were selected from a given social

culture, and hence presumably measure an individual's ability to adapt to and absorb that particular kind of culture. The test scores of our Indian and white children thus simply measure, not their general adaptive ability, but their ability to adapt to our type of civilization. Let us assume that we now devise a set of exercises that are typical of the cultural traditions, mental habits and mode of life of a tribe of desert Indians. It would not be at all surprising if white children were at a decided disadvantage in this test as compared with a similar group of Indian children. The test scores, again, would merely indicate the relative ability of the two groups to adapt to those environmental conditions rather than any difference in general adaptive ability. In all racial comparisons, we must avoid making any general conclusions as to racial superiority on the basis of tests that are adapted to particular cultural conditions.

Native Intelligence and Social Control. — It is generally assumed that the doctrine of native intelligence implies the further conception that this ability is not amenable to social control. As a consequence, the assertion is made that a child's I.Q. can not be altered. It is maintained that defects can neither be remedied nor prevented. The low intelligence quotients of certain individuals, social classes, and races must thus be accepted as given and unalterable facts, and our educational and social policies must be readjusted so as to conform to those facts.

This fatalistic conception of the development of intelligence is entirely unjustified. It is based upon the fallacious assumptions that the development of this ability is wholly determined by innate conditions, and that these conditions are not subject to any form or degree of control. As we have previously stated (p. 416), the fact that native

conditions are responsible for the difference between two individuals in respect to their *rate of development* does not justify the further assumption that either of these individuals has attained the full measure of development of which he is capable.

The important question concerning this ability is not that of its native character but rather that of its control. The mere statement that a trait is conditioned either by native or environmental conditions gives us no very useful information concerning either the extent to which it can be altered or the means by which it can be controlled. The extent to which the development of any trait can be controlled may be limited by either native or environmental conditions, and the means that must be employed will depend upon the specific nature of these conditions which vary from individual to individual. No one is justified in making any dogmatic statement as to the possibility of control on the basis of *a priori* assumptions. Both the limits and methods of control must be ascertained by empirical means.

First, we need to obtain more adequate information as to the extent to which a given defect of ability can be *remedied.* As possible measures to be adopted, we may mention more adequate instruction, the removal of the child from his home and associates to a more healthful and stimulating environment, the inculcation of habits of industry, the revision of his system of values and attitudes toward life, and the development of proper ideals and desires. There still remains the possibility of influencing an I.Q. by the adoption of hygienic and medical measures, — by instituting regular habits of sleep, correcting conditions of malnutrition, preventing undue excitement, removing adenoidal growths, correcting sensory defects, curing infec-

tious conditions of teeth and tonsils, remedying abnormal glandular conditions, and curing congenital venereal diseases which often yield to adequate treatment.

We lack at present any knowledge concerning the possible influence of many of these factors. One study has indicated that the mental status of a group of children was not materially improved by the removal of adenoids and diseased tonsils. On the other hand, certain of these factors are known to be effective (p. 417), and it is well to note in this connection that some mental defects that are due to congenital conditions can be remedied. We must also recognize the possibility that a given remedial measure may be effective in one case and not in another. Moreover, our ability to remedy such defects may be considerably enhanced with the further development of medical, hygienic, and educational knowledge.

We may next consider the possibility of *preventive* means of control. The mere fact that the low I.Q. of a ten-year-old child can not be subsequently altered does not prove that this lack of development might not have been prevented. As developed in a previous chapter (p. 342), many of the most dominant and characteristic features of mind and personality are established in early childhood, and these traits often persist practically unmodified throughout life. Contrary to popular opinion, it is not our native tendencies, but rather our early acquired traits whose genetic roots permeate every aspect of our being that prove to be so stubborn and intractable from the standpoint of subsequent control. It is thus possible that a child may early acquire certain fundamental modes of reaction that are detrimental to his subsequent development. Obviously these habits when once established are difficult to alter, and yet their development might easily

have been prevented. There are certain facts that indicate that this conception can also be applied to the process of organic development. For example, a recent study has indicated that children who have been treated for the hookworm disease of several years standing do not entirely recover their normal mental status. Naturally, the detrimental effects of this infection might have been prevented by the adoption of adequate sanitary measures.

The possibilities of social control are not yet exhausted, even though we assume that a child's I.Q. can not be altered during the course of its life. The appearance of some of these congenital conditions which unfavorably affect mental development might have been prevented by the adoption of proper medical and hygienic measures on the part of previous generations. Some cases of mental defect may be the product of circumstances connected with birth and foetal development that might easily have been avoided. It is a well-known fact that other cases of mental defect which are transmitted from generation to generation find their ultimate origin in the venereal infection or chronic alcoholism of some ancestor. Such causal conditions might have been avoided. Finally, in so far as intelligence is hereditary in the biological sense of the term, *i.e.*, in so far as an individual's I.Q. is a function of his racial and family stock, we still have the possibility of eugenical means of control. Any fatalistic attitude toward either individual or racial development is justified by neither fact nor theory.

EXERCISES

1. List the various practical purposes for which you could employ a knowledge of the intelligent status of an individual.
2. Define intelligence. Can you suggest any other definitions of general intelligence than that given in the text?

3. What sort of tasks would you employ if you were asked to devise a test for each of the following abilities: Intellectual, volitional, sensory, motor, clerical, musical, executive, memorial, and rational?

4. What devices other than tests could you employ for selecting competent stenographers, machinists, bond salesmen, and high school teachers?

5. To what extent is executive ability a function of tact, sympathy, courtesy, personal appearance, linguistic ability, patience, and confidence? To what extent do you think that each of these traits is measured by an intelligence test?

6. List the various qualities, traits, and abilities that you regard as conducive to success as a physician, a life insurance salesman, a minister, an automobile salesman, a telephone operator, a politician, a college teacher, an athletic director, and a newspaper reporter. Do you think that you could devise a set of tests that would differentiate between these abilities?

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